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Engineering News-Record

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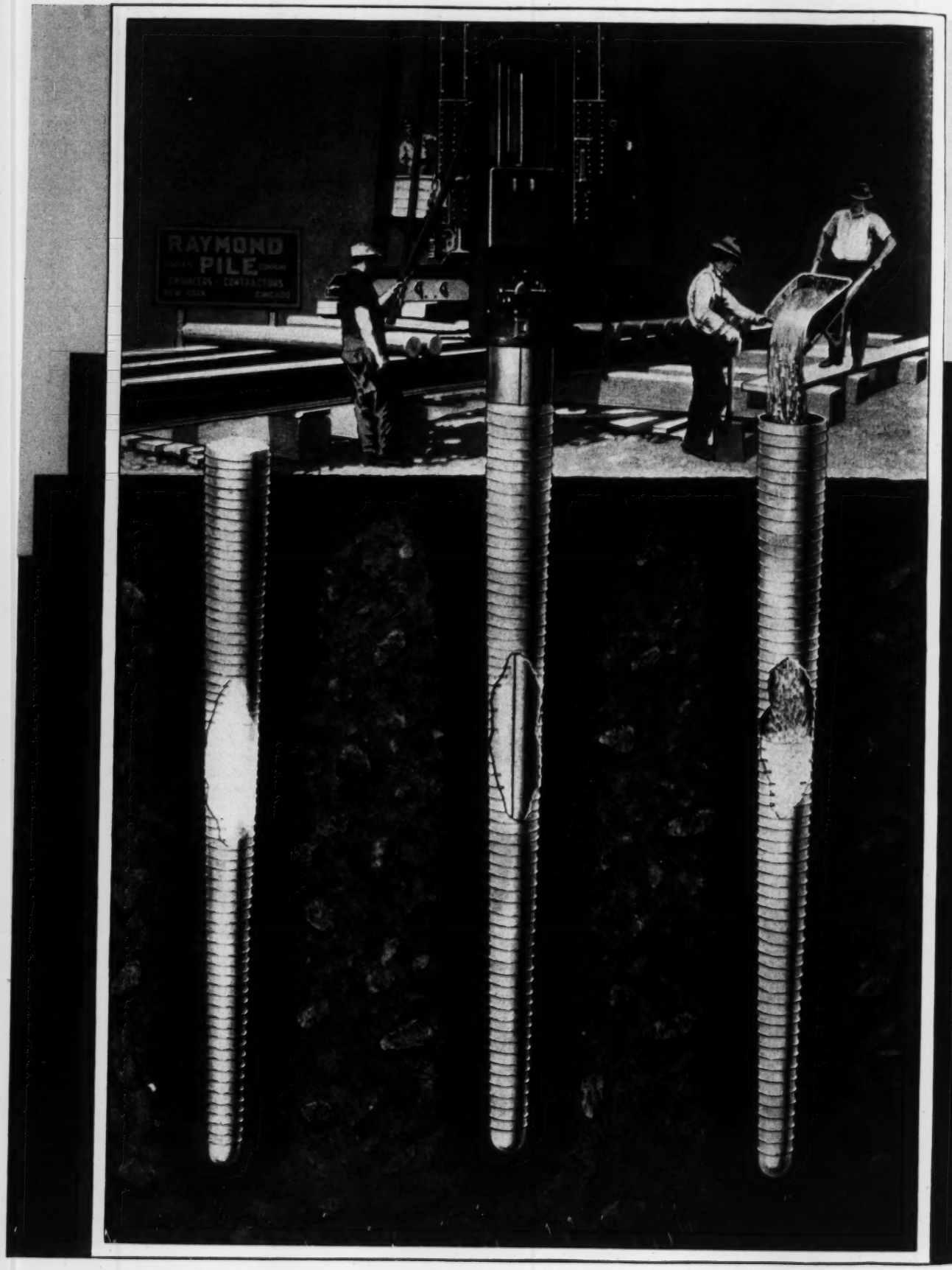
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ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, MAY 15, 1930 Number 20

About Good Sense

IN DISCUSSING state supervision of dams at the recent Sacramento meeting of the American Society of Civil Engineers, M. C. Hinderlider, state engineer of Colorado, remarked that the engineer in administrative work needs a great deal of horse sense. The fact that Mr. Hinderlider himself has more than a thousand dams in his care makes his remark obviously pertinent, for no mere application of rule or physical principle could bring success in a task so large and so varied in its human and other involvements. But the remark is worth remembering in a broader sense. Sound sense is important to the engineer at every stage, and especially important as he is called upon more and more to do administrative and executive work. The orderly thinking and systematic reasoning to which he is trained are most effective when coupled with a fine regard for the surpassingly important human element that lies between cause and effect in all such work and that, while it enters effectively into the equations, cannot be made an algebraic symbol. Tact, good sense and judgment must be written down as a vital part of the engineer's life equipment.

Meeting Modern Demands

IN NO field of engineering activity are modern demands for speed more urgent than in that of office-building construction in our large cities. The reason is simple: The large loss inherent in unproductive land places a premium on the early replacement of old buildings after they have been vacated, and the high cost of borrowed money is a strain on the resources of the owner. Briefly, speed in building has acquired a high dollar value, and on this account engineers and contractors in the building field have had to revolutionize old methods. They have done so with apparent ease and facility, which not only tends to dim the luster of the accomplishment but also creates danger that its immediate value to the engineering profession may not be fully appreciated. One would naturally expect that increased proficiency and ability had played an important part, and a study of numerous building projects checks this expectation. But it also reveals something more significant—namely, that the real basis of modern building speed lies in organization, efficiency and planning, which taken together may be termed co-ordination. A case in point is the 71-story Manhattan Company Building, which was built complete, including wrecking of old buildings on the site, in 33 weeks. Such performances as the construction of new foundations while the wreckers still were busy overhead, completion of the foundations after steel erection had begun, fabrication of the steel in five widely separated shops, erection of 2,100 tons of steel in one week and the maintenance of a weekly average of 1,600 tons throughout the first six weeks, and dovetailing of the operations of half-a-hundred subcontractors, are not the result of new advances in the art. They resulted wholly from co-ordination, made possible by a fine sense of organization on the part of the general contractor and an appreciation of its necessity on the part of the owner, the architects and the engineers.

Consultant's Costs

IF COSTS of operating an office for consulting practice were more generally known, there would be fewer youngsters opening offices before they had acquired enough experience to make a readable report or enough financial backing to keep the sheriff away. Few data on what it costs to run an office, get business and care for it are available. However, the necessity for making income tax returns has made it imperative that the engineer know his total costs, and in a paper recently presented to the Iowa Engineering Society Charles H. Young made so bold as to present facts and figures telling how he determines them. He has charted his receipts and expenditures for each year since 1910. One interesting conclusion is that, barring years of depression, it is necessary to charge a client twice the nominal salary rate of assistants in order to make a 10 per cent profit on men employed, resulting in a 40 per cent overhead for this salary item. Mr. Young quotes three other consultants as stating that their overhead operating costs are from 35 to 40 per cent. In detail Mr. Young lists 51 items that he considers essential in analyzing his costs. They range from cost of compensation insurance to that of training new employees. Definitely, his expenses have ranged for the years 1923 to 1929 inclusive from 67 per cent to 121 per cent of his income, with an average of 75½ per cent. More data of a similar nature should be available.

Using Material Efficiently

THE design of steel beams combined with concrete floorslab and incasement hinges wholly on the question of using material efficiently. That the slab co-operates with the beam is well established, not only by the results of three or four extensive series of tests but also by the outcome of many years of practical experience. The new tests of the Western Society of Engineers add nothing to the substance of prior knowledge, though they furnish useful data to strengthen convictions in favor of taking due account of the combined action of beam and slab. So far as the attitude of engineers is concerned this added evidence is not much needed, but it is important for its effect on building codes and other prescriptions that govern most building. The time is at hand when city building codes should take combined load-carrying action into account and put an end to the waste of material which its neglect involves. Whether the simple

rule recommended by the Western Society committee—designing the steel beam for 24,000-lb. stress in place of true calculation of the slab-and-beam action—is adequate and whether safeguarding provisions are necessary to assure proper bonding of steel and slab are questions not difficult to dispose of. The important thing is to shape codes and specifications to embody recognition of the proved physical fact that slab and beam act in co-operation. It means a few millions saved in the country's annual building bill—not much in the total, perhaps, but well worth striving for.

Welding Theory Needed

EMPIRICAL knowledge of welding as developed in the past eight or ten years has provided the basis for the advancement of this new method of structural steel jointing. In the main, it is possible to connect beams, girders, columns and truss members to one another by welding with considerable confidence. But the theoretical background, the ability to analyze and explain, which has always been the bulwark of other fields of science, has been lacking in the field of welding. The reason why certain joint arrangements stood up while others failed has not always been easy or even possible to explain. The attempt, therefore, made by L. C. Bibber, of the Navy Department, as reported two weeks ago before the American Welding Society, to develop a theory of stress distribution in welds and of stress transfer through them is an important step forward. Whether the theory and deductions are correct in every respect is not vital at the moment. The important factor is that something has been done to rationalize welding design, and that other analytical minds may be stimulated to emulation. With abstract thinking going along with actual tests and experience, we are bound to discover and corroborate new facts. Mr. Bibber's analysis showed that lack of metal-to-metal contact between the elements joined by a fillet weld does not affect the efficiency of the joint in any way. If this be true, one difficulty for the designer has been eliminated. As other facts are determined and as stress actions in welds become more clearly understood, structures will be erected with more efficiency and more assurance of safety.

Bridge Difficulties

THOSE who keep records of leading structures of different types will take note of the just-completed highway bridge over the Columbia River at Longview, Wash., as the longest cantilever in the United States and the second in length on the American continent. The Quebec cantilever surpasses it; the east span of the Queensboro (Blackwells Island) bridge is a few feet shorter. But in these days of growing span lengths the magnitude of the bridge is only a secondary distinction; its more noteworthy feature is the fact that its builders had to overcome remarkable opposition before they were able to carry out their enterprise. Bitter hostility was centered on the project by commercial interests of Portland, which insisted that the river must be kept unobstructed below the mouth of the Willamette in order that the city's position as a seaport should not be jeopardized, but probably also feared the creation of a new north-south travel route. Because of this opposition, Congress took the approval of bridge clearances and pier locations out of the hands of the War Department and vested it in three government departments jointly. These departments rejected the original plans and called for spans and clear heights so great as to make the commercial practicability of the project seem almost hopeless. When, despite their severity, these conditions were met in the revision of the plans, the representatives of the departments did not regard themselves as bound by their first findings but held another hearing and still further increased the clearance requirements. The result was in accord with the trend of recent War Department bridge rulings, to discourage bridge construction wherever possible in favor of presumptive future navigation convenience. Further, it fitted the Portland side of the controversy to a nicety. The bridge was built despite the severe requirements. It must bear a heavy burden of excess cost throughout its life, and some of this will fall on the city of Portland and its tributary territory.

An Earth-Slip Problem

VARIETY of phenomena is the principal fact met with in all considerations of earth slips as they affect the work of the roadbuilder. It accounts largely for the multiplication of devices which are described by W. S. Downs in this issue as being employed by the West Virginia highway department to conquer sliding earth and rock. Walls of different kinds are built to restrain the moving material or by drainage or blasting the physical nature of the soil is modified so that it becomes stable. Each of these means is successful in some instances and in other instances is a failure; thus, drainage is of no account when a firm material overlying a soft material causes it to flow by squeezing. The interesting record of experience is a reminder of the fact that both the phenomena and the available remedies of earth slips are old: at least half a century ago the early railway builders discovered them and read papers about them before the engineering societies. Our new and costly highway construction brings out the problems of sliding ground anew, but we still must depend on old expedients in our curative attempts. Soil science has given little help, so far, either in diagnosing possible occurrence or in providing something better than cut-and-try procedure when movement manifests itself. A wall is built, or the slipping ground is drained, or the filling cut is dug out until equilibrium comes about. It is pertinent to ask if our modern soil engineering research cannot find something better to aid the roadbuilder in protecting large mileages of costly highway against earth and rock slip hazards.

Imperishable Framework

HARDLY more than thirty-five years have passed since city buildings with fireproof steel frames were built in any considerable number. In the early years of this period, doubts were often voiced as to the durability of such buildings; many men suspected that the buried steel might be rusting away from moisture and sulphur attack, the latter especially where cinder concrete was in contact with the steel. When buildings did not fail or show signs of weakness, less and less was heard of these suspicions, but they never wholly died out. Beginning about fifteen years ago a few steel-frame buildings have been taken down to make way for larger and more profitable buildings, and thus opportunity was obtained to see the condition of building steel after long service. The Gillender and Tower buildings and Madison Square Garden in New York, and the Tacoma Building in Chicago, were among these instances; each showed the general

condition of the steel to be excellent, but in one or two cases certain small parts of the frame were much corroded by water that penetrated poorly built covering of the steel—most notably in the tower of Madison Square Garden, whose sheathing was ineffective. Now comes the evidence of the Waldorf-Astoria Hotel, in New York, which stood more than thirty-five years. This structure diverged less from normal practice than did some of the other buildings mentioned; its wall and floor construction, column incasement and roofing were substantial, even though a few details of the construction were below modern standards. The condition of the steel is recorded as being excellent—in fact, the columns and beams were as good as new. Noticeable rusting was seen at only one minor column, affected by a court-roof leak, and even here the loss of load-carrying section was negligible. The evidence is clear proof that the steel frame would have given unimpaired service for an indefinite time. Thus the last remnant of the former suspicion about the life of the steel framework of city buildings is finally laid to rest; it may now be set down as an axiom of building that until its masonry covering is torn or shaken loose a well-covered and incased steel frame is imperishable.

An Engineer's Public Service

THE quality of our municipal governments depends upon the collective efforts of the individual. It is good or poor depending upon whether the majority of those who direct its affairs are well trained or are uneducated in such matters.

Civil engineers by their training are peculiarly fitted to advise cities upon many municipal matters and to take part in the direction of city affairs. But few of them do. Too many sit by and decry the fact that their qualifications in that respect are unappreciated. In this the fault lies with them rather than with the public; if they are to be appreciated they must take the initiative and so let the public know what they can do.

The late Louis R. Ash was a splendid example of how effective engineers can become in municipal affairs if they make it their business to take more than a passive interest in civic problems. Of him the Kansas City *Star* said at the time of his death:

"Louis R. Ash was a type of citizen that every city needs. His profession of engineering may have had something to do with his high regard for system, efficiency and order and with his intolerance toward things haphazard, including city government. He was assertively public-spirited. He recognized the obstructive effect of pernicious partisanship in city affairs. He helped to procure the adoption of the new charter after he had helped to frame it.

"Every genuine movement for municipal progress had his support. Some have been successful and some have failed, but Mr. Ash never lost his zeal for better standards of government. In his death the city loses an individual factor in courageous civic effort. Even those who disagreed with him or lacked his faith in ultimate accomplishment acknowledged his sincerity and respected his motives."

This country needs more such engineers. They may not be right at all times; they are sure to be misunderstood and abused frequently; but in the long run they will make an impression that will be felt and will be appreciated as Mr. Ash's service to Kansas City is appreciated.

Progress in Credit Reform

IN A decade of enormous expansion the construction industry has fallen upon evil days by following lax credit practices. It is now laboring to change its course and, as is shown by the account of the Associated General Contractors' board meeting two weeks ago, is having creditable success. There is real promise of reform in the activities now inaugurated and in the agencies that have been created for stabilizing credit. Conference and co-operation are achieving progress where independent and coercive action had failed.

Contractors who purchase equipment, materials and money for construction, and those concerns which sell these services to contractors, are now working out credit problems together. The National Builders' Supply Association is co-operating with contractors' associations in encouraging local credit bureaus, and such bureaus are now operating in some twoscore cities. Jointly with a dozen associations representing the building sub-trades, the building division of the Associated General Contractors has decided on a code of fair practice, an essential part of which is a standard credit system. The engineering construction division on its part has sponsored the credit control plan operating in Illinois between contractors and materials producers; the plan is being inaugurated in Texas and in New York and is being considered by other chapters of the association.

A fundamental activity tying in with these division credit agencies is the general survey of contractors' credit qualifications by the bureau of contract information. Remarkable progress has been made in the work of this bureau, which is being financed by the surety division affiliated bureau of the Associated General Contractors. There are now completed in the bureau files the fully verified records of some 2,400 contracting organizations, and the list is being increased daily. It is the purpose of the bureau—backed by the surety companies now writing 95 per cent of the construction surety bonds in America—to establish and record to date the past performance of every contracting organization carrying on construction of an engineering character.

The function of the bureau of contract information is solely factual—to provide complete and accurate past performance records. Beyond the facts of the record it will make no pronouncement on any contractor. In all the credit activities cited there is no undertaking to name prices or to curtail the freedom of buyer and seller beyond the fact that standard credit terms shall be adhered to in all sales and purchases. These terms, too, are to be the same to every contractor whether or not he has association affiliations, is new in the business or has a long and honorable record of work performed and obligations met.

The Associated General Contractors is undertaking a hard task in endeavoring to stabilize credit practices in a highly competitive and intensely individualistic industry. Its progress will depend on two things: first, on the individual contractor's willingness to comply with restrictions from which he has been free, and second, on the support which the engineer as the agent of the owner will afford it. The engineer and owner have everything to gain by stabilizing credit practices in construction. Only through its help can they eliminate the irresponsible contractor. Only in this way can the purveyor of materials and equipment be taken out of the business of financing contractors, a business in which he has no place and to which he has brought loose practices.

Earth Slip Hazards and Control in Highway Maintenance

Three Types of Slips Act by Overflow, Upthrust and Undermining to Destroy Roads—Water the Activating Element in Most Sidehill Slips—Piling and Walls Essentially Palliatives, Drainage Is the Cure

By Willam S. Downs

Consulting Engineer and Formerly Division Engineer, West Virginia Highway Commission, Morgantown, W. Va.

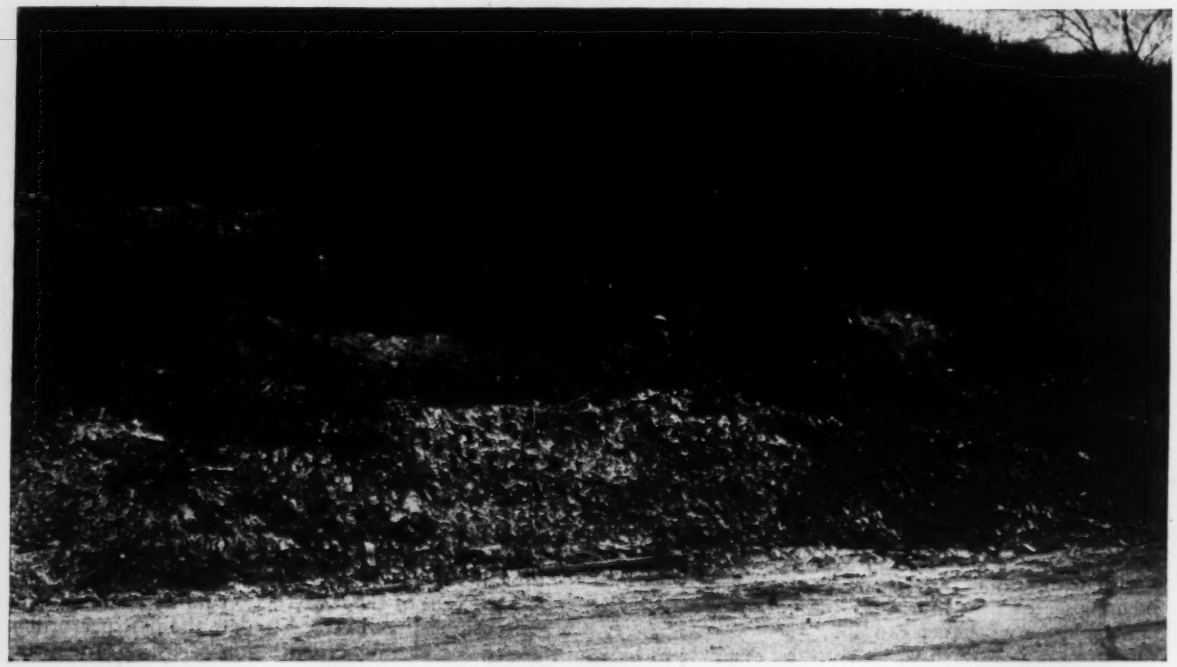

FIG. 1—TYPICAL BROKEN SURFACES OF LARGE SLIDE

Sometimes the moving material is of considerable depth, as shown by the standing man, and the slide covers an area of several acres, showing a broken surface.

HILLSIDE slips present a serious problem in highway maintenance in southwest Pennsylvania, eastern Ohio and West Virginia. In general any landslide or movement in the subsurface strata is called a slip. From the viewpoint of highway maintenance, however, slips may be divided into three classes: (1) those which move into the road from higher ground and pile onto the road surface but do not damage the pavement; (2) those which are caused by the settlement or slipping of higher ground and by reason of the subsoil conditions destroy the pavement through lateral or upward pressure, and (3) those which move out from under the highway and result in the sinking or subsidence of the subgrade or road surface.

To summarize briefly the conclusions to be demonstrated in detail, the general remedy for the first class of slip may be drainage, the removal of a portion of the slipping material or restraint by cribs or piles. As a rule expensive sub-drainage or retaining walls are not justified. For the second class it is usually necessary to raise the grade of the highway over the slip. The third class can best be controlled by adequate drainage or by retaining walls, but rarely is it worth while to trust to piles or superficial drainage. The imperative necessity of providing a firm unyielding foundation for the pavement justifies more costly efforts to the end that immediate and positive results may be obtained in stopping the earth movement.

Occurrence and Character of Slips

Sometimes, though not often, the movement which causes a slip may take place within the bedrock formation, as when a soft fireclay shale squeezes out from under the superimposed harder rock, causing the latter to crumble and move out of its natural position. As a rule, however, slips occur in the earth composed of disintegrated rock which overlies the bedrock and which consists of the weathered shales or alluvial deposits commonly called the subsoil.

Most of the shales in the soft coal regions disintegrate very rapidly when exposed to the air and to alternately moist and dry conditions, and the detritus from these weathered shales piles up on the hillsides in more or less unstable equilibrium, to move or slip whenever it is disturbed by excavation, by superimposed loads or by any increase in the normal moisture content. Moreover,

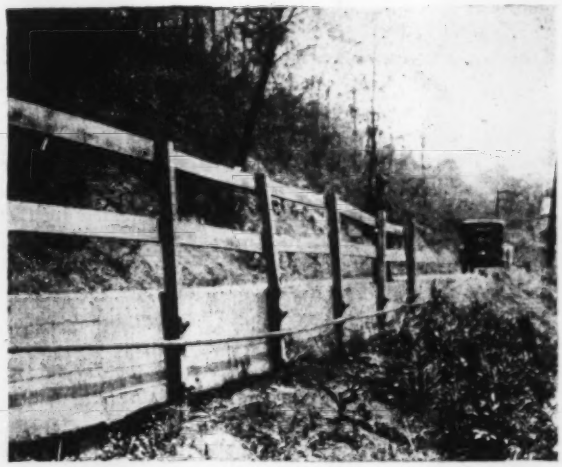

FIG. 2—PAVEMENT DESIGNED TO BRIDGE SMALL SLIP

the débris from the weathered shales is slowly but constantly moving downward with each succeeding disturbance. It is frequently observed that with a sufficient water content the earth and water become so thoroughly mixed that the product literally flows, like soft mortar, down the hillside, piling up immense rolls or hills of soft earth which may later dry out and become firm soil.

Sometimes, when the surface of the ground is covered with sod and the mass of moving material is not great, the movement or flow of the sub-soil may not break the surface but is indicated only by rolls or undulations in the sod surface; occasionally the semi-liquid earth mixture may break through the sod covering and flow on the surface of the ground.

It is not uncommon in the early spring, when the moisture content of the ground is at its maximum, to observe while traveling along the highways, especially those highways which have been graded or constructed within recent years, that the earthy material which covers the rocks on the hillside is slowly moving into the road. Its form varies from a thin mud, which flows like a stream of water over the excavated rock cut, to a thick, earthy mass, which moves with glacier-like slowness to break off in pieces and fall to the roadway. The drainage ditches along the highway become filled with mud and masses of soft earth spread out onto the road surface to the extent of interfering with traffic. Much of the maintenance cost on these highways is for the constant removal of these small slips and the re-excavation of drainage ditches.

Sometimes the moving material is of considerable depth and covers an area of several acres, often more or less broken or cracked, though occasionally moving as a solid mass, carrying with it trees and sometimes buildings. (Fig. 1.) In Barbour County, W. Va., a large slip or landslide of this nature was observed to move from a wooded area on the hillside to a pasture field near the base of the hill. The trees, some of them 2 ft. in diameter, were transported in their natural positions and when the slip came to rest were left standing on the land which formerly was a pasture field. When these slips occur in towns or cities the loss or damage is sometimes enormous; they destroy buildings, disturb or move the paved streets and break the sewer, water and gas lines. Morgantown, W. Va., has experienced several misfortunes of this nature.

Frequently a slipping hillside forces the ground upward at its base, forming small mounds or hummocks in the more level land at the bottom of the slope. (Fig. 4.) These mounds or hummocks often create back of them pockets or depressions which collect the surface water and thus create a condition conducive to further slips.

Although the earth movement is usually confined to the so-called sub-soil, the slipping plane for the movement is not always on rock. It not infrequently happens that a slipping plane is developed within the earth, so that one mass of earth is found slipping on and moving over another. Sometimes the slipping plane is a very thin layer of clay resembling a fireclay, probably not more than $\frac{1}{16}$ in. in thickness and exceedingly smooth and slippery. It forms an impervious parting in the sub-soil and inclines at an angle to produce the slip. The surface of the plane has a greasy feel and is not unlike the so-called "slickensides" found in the shales of the soft coal mines where breaks occur.

The highway locating engineer can, and often does, avoid slipping hillsides, but quite often he is mistaken in his judgment of geological conditions and frequently it is impossible to locate the highway on firmer foundation. Then he must devise methods to control slips.

Various Devices for Controlling Slips

Ordinarily methods of controlling slips must be other than excavation of the moving ground. Frequently the cost of such work is prohibitive and, moreover, in ordinary highway work such a drastic measure is not necessary.

FIG. 3—UPTHRUST OF SOFT BOTTOM STRATA
This upthrust tilted pavement and raised it some 5 ft.

In one instance in central West Virginia, where the excavation for a new highway disturbed the base of a hillside which showed unmistakable evidence of ancient slips, the earth break extended several hundred feet up the hillside and paralleled the road for more than 800 ft., threatening to bury the highway and require the removal of more than 50,000 cu.yd. of earth, a very expensive operation.

Drainage Solved the Problem

In this instance a retaining wall or piling was impracticable, for soundings indicated a depth of more than 40 ft. to a solid foundation. Likewise sub-drainage was out of the question. However, the problem, as in most slips, was the removal of the water so that the slipping material might dry out and become stabilized. This was accomplished by taking advantage of the warm summer

weather to permit the sun's heat to evaporate the moisture.

First the brush, weeds and grass were cut from the hillside and burned, thus exposing the soil to the direct rays of the sun. Near the top of the slip, water was found seeping from a ledge of sandstone and soaking down through the slip. This water was led off in ditches over the surface of the slip, care being taken to smooth and plaster the bottoms of the ditches with mud so that the water might not enter the soil but would flow on top of the ground to be evaporated by the heat of the sun. For several months care was taken to seal up any cracks or holes by which the water might enter the slip, and all pockets or pools of water were carefully drained by surface ditches.

The earth movement finally ceased as the slip dried out so that the excavation for the highway was completed without further trouble. Moreover, the slip having once been stabilized by this drying-out process, its equilibrium has been maintained even in wet-weather seasons through a period of more than five years since the highway was completed.

Slips very rarely occur in dry soil, but almost invariably are the result of water saturating the soil to such an extent that it loses its stability. Hence the remedy for the control of slips is usually a drainage problem, which is first to find the source of the water and then to devise means for its proper removal. Especially is this true when the highway is endangered by the development of a slip beneath the roadbed.

Retaining Wall Control Difficult—In some cases when the depth of the slipping material is not too great and where a suitable foundation is available, a retaining wall may be advisable. However, this is sometimes a very costly remedy, since the wall must be designed and constructed to withstand hydrostatic pressure with a superimposed load often extending well above the level of the top. Walls of the gravity type, apparently well constructed on solid foundations and with a thickness of base of more than 40 per cent of the height, have failed by overturning under the hydrostatic pressure of watersoaked slips. That conditions may exist where drainage is extremely difficult if not impracticable is illustrated in the failure of a concrete retaining wall along the West Fork River in West Virginia.

This wall was founded on solid rock which outcropped along the river at the approximate elevation of low water. The thickness of the base was approximately 40 per cent of the height and plenty of weep-holes were provided for drainage. The backfill was earth which was dry when deposited. However, a rapid rise of the river thoroughly saturated the earth backfill and with the subsidence of the water, which quickly released the water pressure on the face of the wall, the resultant forces exerted by the watersoaked backfill, with its superimposed load, completely overturned the wall.

Piles Not a Permanent Remedy—Piles have frequently been used to prevent or stop slips. Observations would indicate, however, that they are more often successful as a preventive than as a cure. They frequently retard a slip but are not a positive means for stopping a slip which has once been set in motion.

Two types of piling have been used in the soft coal regions of West Virginia. One is the ordinary wood pile, driven with a pile hammer; the other consists of oil-well casing placed in holes which are drilled through the slip and into bedrock with a well-drilling machine. Sometimes the hollow casings are filled with concrete, and in some instances attempts have been made to tie together the tops of the piles, which are set in parallel rows, by constructing a concrete cap over and around the tops. In no case can it be shown that the concrete cap served any good purpose.

Steel-casing piles have an advantage over wood piles because they penetrate the solid rock to provide a firmer anchorage to resist the thrust of the slip. They are therefore best adapted to slips in which the plane of movement is solid rock. On the other hand, the wood or driven piles are less costly and more efficient when the slipping plane is within the softer subsoil material, so that the piles may penetrate through and well below the plane of movement.

All piles facilitate the drainage of the slip and may retard its movement if properly driven, but the writer believes, from extensive observations over wide areas, that in very few instances can it be demonstrated that a permanent cure is effected. Sooner or later the piles fail or tend to move with the slip. In the observation of approximately 30 slips where piles have been used, more than 75 per cent show indications of pile failure

FIG. 4—GROUND BULGED UP BY SLIPPING HILLSIDE

after from three to five years. If the slip is moving into the highway, piles may often serve a good purpose in arresting the movement sufficiently to enable adequate maintenance. However, when the slip extends beneath the highway the resistance of piles is rarely sufficient to prevent sinking and cracking of the surface.

Crib Walls Effective Within Limits—Another more or less temporary expedient for stopping slips, where the mass of moving material is not too great, is a wood crib constructed of logs or timbers with frequent headers and often backfilled with stone. Sometimes precast concrete beams have been used for this purpose. The crib construction facilitates drainage of the slip and apparently shows a higher percentage of efficency than piles, but its use is limited to slips of comparatively little depth.

Successful Drainage Practices—Ordinary tile and broken stone drains constructed for draining slips and slip material show very poor results except where they have been constructed in a solid material well below the slipping plane, in order to lead away a stream of groundwater. The material composing the ordinary slip mixes with the water to form a mortar which tends to seal up the underdrain, and it is only when the volume of water (usually groundwater) is of sufficient and constant flow to keep the underdrains clean that such drains properly function. Moreover, these drains soon become displaced if embedded in moving material; hence they should be placed in the firmer material below the slip.

Perforated corrugated pipe has proved a most excellent material for such drains, showing a better flow of water into the pipe with less tendency to displacement. Numerous examples of successful slip control exist where corrugated pipe has been used to drain the "spring" or groundwater supply that caused the slip. Some of these operations have been rather expensive where the source of water was found at a great depth, requiring deep trenches and sometimes tunnels. However, where the work was thoroughly and carefully performed the results have, for the most part, been of a permanent nature.

Another method of draining, which at the same time provides support to slipping material, where the movement is below the road and the slip is of extensive limits, is to dig a deep, wide trench into the slip, starting at its base and following up the flow of water which is often encountered in the bottom of the slip. A power shovel is often found economical for this work. The trench is then backfilled with stone, cinders or granulated blast-furnace slag, which permits free drainage of water and also serves to buttress the slip against further movement. Sometimes several of these filled-trench abutments have been constructed for a single slip, usually with very satisfactory results.

In the maintenance of its highways over slips the Pennsylvania highway department has, with apparently good results, used granulated slag to underpin concrete pavements and to refill the roadbed where the material has slipped out. The slag is light and places no heavy burden on the slip. Moreover, its loose, porous structure permits free drainage, and it has the added property of consolidating into a stable mass resembling concrete.

Blasting a Doubtful Expedient—It would seem from years of observation and experience in the soft coal regions herein referred to that the promiscuous shooting of slips with explosives is of comparatively little benefit, except where a thorough and careful study has been made beforehand to determine the rock conditions and to plan intelligently the results to be accomplished. One instance is noted in West Virginia where a line of holes, located on the axis of the slip, was drilled into a hard, impervious sandstone stratum underlying the earth movement, and with carefully gaged charges of explosive placed in these holes and fired simultaneously, a broken stone drain was provided beneath the slip at comparatively small cost. The breaking of the underlying rock stratum not only provided drainage but increased the frictional resistance enough to stop the slip. However, the same plan when applied to another slip with apparently similar conditions was a failure.

There are other instances where the promiscuous breaking up of the underlying rock formations by blasting has served only to form water pockets and to loosen up the slip material so that it became more thoroughly mixed with the water, with the result that the earth movement was accentuated rather than retarded. Unless the blasting will provide proper drainage of the groundwater, it is apparently a useless procedure.

Slips Due to Differential Pressure

A form of earth movement often encountered on highway construction and maintenance in northern and central West Virginia is where the differential pressure resulting from cuts being made in slip material causes an upward thrust in the roadbed that pushes the pavement upward. (Fig. 3.) Apparently the exposed surface of the cut has sufficient drainage to prevent its slipping into the roadway, but the material beneath the roadway, not having the proper drainage, is soft and saturated with water. The weight of the earth in the sides of the cut, bearing on the underlying softer material, produces a hydrostatic pressure which is transmitted beneath the pavement and produces an upward thrust that lifts the road surface. In Harrison County, W. Va., where the grading of a highway required a through cut approximately 20 ft. deep, there was little difficulty in maintaining the side slopes of the cut, but it was found almost impossible to excavate the roadbed to the proper depth of grade on account of the upward movement of the floor of the cut. The earth upon being removed was soon replaced by earth thrust upward from the bottom of the excavation. Attempts to provide drainage beneath the road proved futile and it was necessary to raise the grade of the road through the cut in order to establish equilibrium. It frequently happens that after excavating for a road it is necessary, before paving, to raise the grade in order that sufficient weight of material may be deposited over slips of this type to prevent the upward movement which would soon destroy the paved surface. Experience has demonstrated that the most successful method of coping with this type of slip is to raise the grade of the road.

This type of slip is confined almost wholly to excavation in earth. However, it is interesting to note that in Lewis County, W. Va., a similar situation developed where the excavation was in a hard sandstone. However, underlying the sandstone and beneath the roadway was a thin stratum of very soft fireclay shale. The weight of the sandstone exerted a pressure on the somewhat soft and plastic fireclay which caused it to squeeze out beneath the roadway after the removal of the excavation near its outcrop. At the same time a vertical crack developed in the overlying sandstone strata forming the side of the cut at a distance of about 40 ft. back from the face of the rock, and the settlement of this mass

of sandstone which had thus become detached from the rest of the ledge required the removal of several thousand cubic yards of additional rock.

Designing Pavements for Slips

Several attempts have been made in West Virginia to design a concrete pavement with a view to bridging small slips which occur beneath the roadway. One plan (in Doddridge County), where the slip was narrow and extended only part way beneath the pavement and where the proximity of a railroad below the highway precluded the adoption of other plans which might have been cheaper, was to support the lower side of the concrete pavement on steel-casing piles, placed approximately at 6-ft. centers and driven well into bedrock. A floor system of reinforced concrete, formed in the earth subgrade and poured with the pavement, carried the load to the top of the piles on the one side and to the rock subgrade on the other. But the movement in the slip ultimately caused the piles to buckle, resulting in failure of the structure. However, a similar type of construction for bridging a slip in Monogalia County, West Virginia, completed in 1917, is still giving good service. It is illustrated in Fig. 2.

High Unit Stresses Recommended for Concrete-Cased I-Beams

Committee Proposes 24,000-Lb. Unit Stress Instead of 16,000- or 18,000-Lb. in Floor Framing

A RECOMMENDATION for 24,000 lb. unit stress in steel I-beams of floor framing when cased in reinforced concrete and covered with a slab of the same material is the main conclusion of a report presented on May 12 to the Western Society of Engineers by a committee which, in co-operation with the Chicago building department, has conducted a series of tests on floor construction of this type. The committee's explanation and recommendation are quoted as follows:

In floor systems composed of reinforced-concrete slabs carried by structural steel beams incased in concrete monolithic with the slab, little or no credit is given this incasement from a load-bearing standpoint. Fireproofing and weatherproofing the steel are assumed to be the only functions of such covering. On the other hand, structural steel columns incased in concrete are more commonly designed with higher unit stresses than those not incased. Many concerned with the design, construction or testing of floor-beams have recognized that concrete incasement not only stiffens the beam but by acting with the steel and concrete slab actually carries a substantial portion of the load, or, in other words, reduces the stresses calculated in the steel. To verify this and to determine the relative effect of the concrete on the working stresses in the steel was the purpose of this floor test.

Our committee recommends unanimously:

1. That with materials of the quality used in this test, 24,000 lb. per square inch be used as a working unit stress in designing structural steel I-beams up to 24 in. in depth when wrapped in steel wire fabric or mesh and incased in a rectangle of concrete with a minimum covering of 2 in. on the flanges of the I-beams and when used in connection with a concrete floor slab not less than 2½ in. thick above the top flanges of the I-beams.

2. That concrete of the quality used in this test may be used in slabs 4 in. thick and reinforced with continuous steel fabric or mesh in spans of not to exceed 8 ft. in accordance with the following formulas, in which W = total load, in pounds per square foot; D = depth to steel, in inches; A = area of steel, in square inches per foot of width, and L = span in feet.

Cinder concrete..... $W = 26{,}000\frac{DA}{L^2}$

Gravel or stone concrete.. $W = 30{,}000\frac{DA}{L^2}$

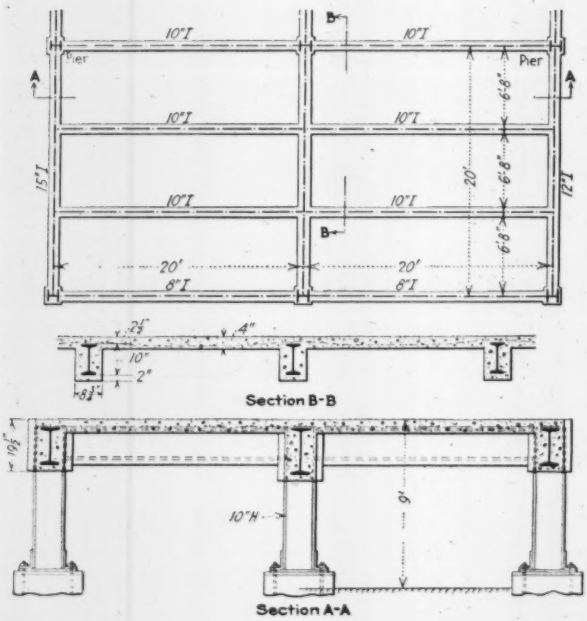

FIG. 1—TEST FLOOR OF CONCRETE-CASED BEAMS

From a review of earlier investigations in this country and abroad, including the Canadian tests described in *Engineering News-Record* of May 3 and June 28, 1923, pages 800 and 1116, the committee reports that the following facts are typical: (1) The concrete and structural steel act together to form a composite beam. (2) The influence of the concrete prevails under vibration or impact. (3) Observed stresses in the steel and deflections in the slab are far below those computed on the assumption that the entire load is taken by the steel alone. (4) A considerable economy in the support of live loads may be obtained by utilizing the joint action of the concrete and steel. (5) Within practical limits the composite beam conforms to theory and may be designed by methods analogous to those used in the case of a reinforced-concrete T-beam. (6) The added strength of the concrete may be taken advantage of in the design by the simple method of adopting higher unit working stresses in the steel and then, with these stresses, calculating the steel alone.

Test Floor—For the 1929 tests, the floor framing, Fig. 1, was 40x64 ft. consisting of four panels 20x20 ft. and two 20x24 ft. Each panel was subdivided by two intermediate beams, spaced 6 ft. 8 in. in the smaller and 8 ft. in the larger panels. This framing was supported on steel columns with concrete footings, giving 8-ft. headroom for convenience of observation and inspection. Gravel concrete was used in the smaller panels and cinder concrete in the two large panels. The 4-in. slabs were designed according to the New York building code, using the same formula for interior and end slabs, although the latter carry greater bending moment. The top of slab was 2½ in. above the tops of the beams. Concrete casing, placed monolithically with the slab, was rectangular in section and provided a minimum protective thickness of 2 in.

In the steel framing, the I-beams were designed as simple beams carrying a dead load composed of the weight of the part of the concrete floor which they sup-

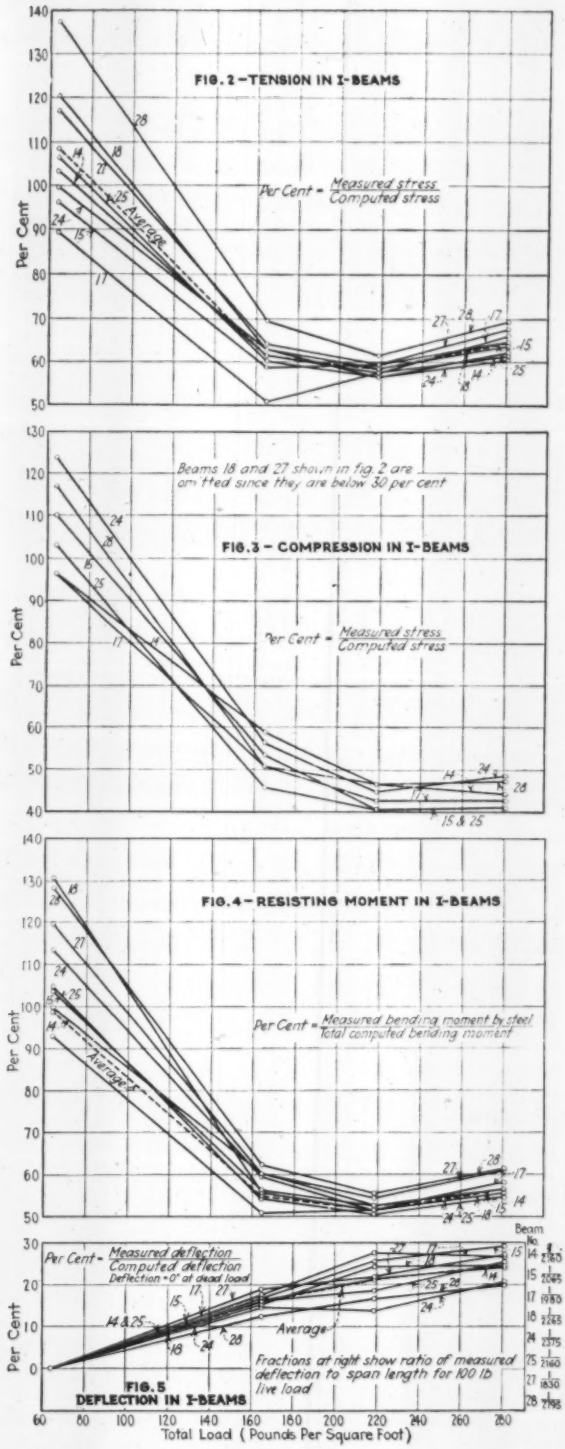
FIG. 2—TENSION IN I-BEAMS
Per Cent = Measured stress / Computed stress
Average
Per Cent
Beams 18 and 27 shown in fig. 2 are omitted since they are below 30 per cent
FIG. 3 - COMPRESSION IN I-BEAMS
Per Cent = Measured stress / Computed stress
15 & 25
FIG. 4 - RESISTING MOMENT IN I-BEAMS
Per Cent = Measured bending moment by steel / Total computed bending moment
Average
Per Cent = Measured deflection / Computed deflection
Deflection = 0 at dead load
Average
Fractions at right show ratio of measured deflection to span length for 100 lb live load
FIG. 5
DEFLECTION IN I-BEAMS
Total Load (Pounds Per Square Foot)
Beam No.

FIGS. 2 to 5—RATIOS OF MEASURED TO COMPUTED STRESSES, BENDING MOMENTS AND DEFLECTIONS

ported, the concrete incasement and their own weight, together with 100 lb. live load. No allowance was made for restraint of the ends or continuity of these beams, but instead of this a unit working stress of 16,000 lb. for the steel was increased to 24,000 lb. to take advantage of the effect of the concrete.

Comparison of Stresses—Records of the tests show a comparison of tensile stresses as in Fig. 2, which gives the ratios in per cent of the measured tensile unit stresses

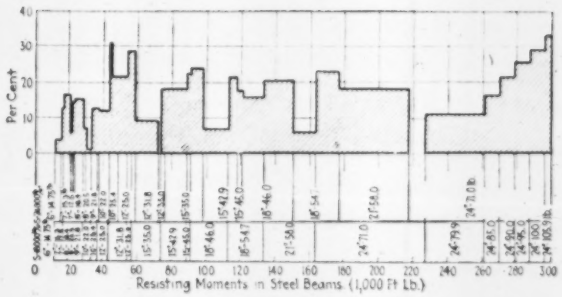

FIG. 6—SAVING IN STEEL WITH HIGH UNIT STRESS
Per cent of weight saved by use of 24,000 lb. instead of 18,000 lb. per square inch. Average saving, 16.06 per cent.

for eight of the 10-in. beams in gravel concrete, the average at the design load being about 62 per cent. Of the several curves of tensile stresses the report says:

> Under the weight of the concrete alone, the ratio of the measured stress to the computed stress approaches unity, indicating that the beam receives its load before the action of the concrete is of assistance. This is necessarily true, since the full weight of the forms and green concrete was suspended from the steel framing. The action of the concrete tends to reduce the stresses in the steel beams considerably beyond the design load, and then its percentage of effectiveness slowly decreases.

In Fig. 3 is shown the ratio of measured compressive unit stresses to the computed stresses in six of the 10-in. I-beams in gravel concrete, with an average of about 53 per cent. Fig. 4 shows the ratios of measured to computed bending moments at the various test loads in the 10-in. intermediate I-beams. It is to be noted that the curve marked "average" is not the mean curve, but the one arrived at by using for a theoretical beam the average compressive and tensile stresses for this group.

Ratios of measure to compute live-load deflection, corrected to the 100-lb. design load, are shown in Fig. 5, which also is for beams in gravel concrete. These deflections average 15 per cent at design load and about 25 per cent with a superimposed load of 217 lb. per square foot. In the cinder-concrete panels, the deflections are greater, but the maximum is only 54 per cent of the allowable deflection for plaster ceilings (1/360 of span), and the maximum in the gravel-concrete panels is only 20 per cent of this allowable ceiling deflection.

Economic Results—The report states that the American Institute of Steel Construction recommends a working stress of 18,000 lb. but that some building codes still specify 16,000 lb. In Fig. 6 are given the sizes of I-beams required for bending moments up to 300,000 ft.-lb. for unit stresses of 24,000 lb. and 18,000 lb., together with the saving in weight by using the higher stress. The maximum saving is 33 per cent and the weighted average saving is 16.06 per cent for the range between 15,800 ft.-lb. and 300,000 ft.-lb. As to the financial result, the report says:

> The sale of structural steel in the Chicago district alone amounts to about 175,000 tons per year. Assuming that half of this tonnage is used in floor construction of this nature, the annual saving would be about 20,000 tons, costing about $1,500,000 erected. This more efficient use of structural steel and concrete, by lowering the cost of buildings of this type, eliminates waste and is of benefit to the general public as well as to engineers, architects, contractors and manufacturers.

Investigating Committee—The committee in charge of this investigation was composed of Frank A. Randall, consulting engineer, chairman; John Brunner, Illinois Steel Co.; Homer G. Farmer, Universal Atlas Cement Co.; Albert Reichmann, American Bridge Co., and Charles C. Whittier, Robert W. Hunt Co.

Building a 71-Story Skyscraper in 33 Weeks

Construction Speed on Manhattan Company Building in New York Accomplished by Extensive Organization of Job and Co-ordinating Subcontractors—Materials Expedited From Source to Job—Steel Shipped From Five Shops to Meet Schedule

ON MAY 18, 1929, the last tenant moved out of the old building at 40 Wall St., New York City. Wrecking the old building was completed June 15, and on Feb. 1, 1930, just 33 weeks later, the 71-story Manhattan Company Building had been completed on this site, except for tenant changes. The first tenant moved in on March 31, and by May 1 the tenant changes had been completed for all the rented space and the principal tenants were occupying the building. This record speed was due to an excellent start on the foundations, which were partly completed by the time the old building was wrecked (*Engineering News-Record*, April 24, 1930, p. 691), and to extensive organization of the job, from thorough preliminary planning to absolute co-ordination of the work of the general contractor and 50 subcontractors engaged in the construction. A summary of the job schedule is shown in Table I. Progress views are shown in Figs. 2, 3 and 4.

The building faces on two narrow streets, Pine and Wall (Fig. 1), in lower Manhattan, New York's financial district. Pine St. is but 19 ft. wide and Wall St. averages 32 ft. wide, curb to curb, at the building site. Getting materials to the job through the narrow, crowded streets of this district was one of the most serious obstacles to overcome. The situation was further complicated by the simultaneous erection of another building on the opposite side of Pine St. Access from the west was almost impossible for steel loads and other heavy materials because of subway construction on Broad and Nassau Sts. Decking on these streets restricted loads to 10 tons.

Many of the tenants of the old buildings on this site took space in the new structure and had to be taken care of in quarters in near-by buildings during construction. The Bank of the Manhattan Company, which will occupy the lower floors of the new building, was temporarily located in a thirteen-story structure on the site of the west wing of the Pine St. side of the new building. Wrecking this building commenced May 1, after the bank had moved into its new quarters. The new west wing, 30 stories high, is scheduled for completion Dec. 1, 1930. Some tenants taking space in the wing are being temporarily taken care of in parts of the completed structure.

Expediting the material shipments was a most important factor in maintaining the construction speed. Representatives of the general contractor were placed in every shop and factory producing the principal materials going into the building. These expediters were in constant touch with the job, and as a result materials moved to the building smoothly, on schedule and at a rate maintained to eliminate excessive storage at the site.

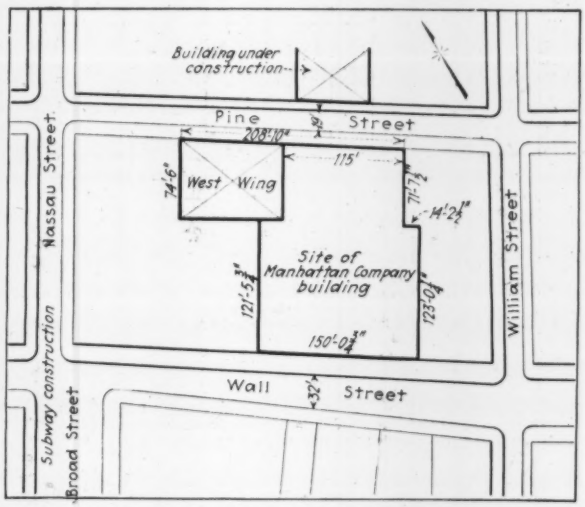

FIG. 1—SITE PLAN, MANHATTAN COMPANY BUILDING, NEW YORK CITY

TABLE I—GENERAL CONSTRUCTION SCHEDULE, MANHATTAN CO. BUILDING

Last tenant out of old building	May 18, 1929
Started wrecking	May 20
Wrecked down to curb	June 12
First steel billet on job	June 20
First column set up	June 27
Steel topped out	Nov. 12
Floor arches, basement mezz. to top	July 8 to Dec. 17
Exterior walls, started at 8th floor	Aug. 15
Exterior walls completed to 57th floor	Nov. 14
Stone started at first floor	Oct. 15
Stone completed to 8th floor	Dec. 16
Stone, 57th to 62d floor, started	Nov. 18
Stone, 57th to 62d floor, completed	Jan. 3, 1930
Pyramid roof started	Dec. 12, 1929
Pyramid room completed except copper facing	Jan. 10, 1930
Copper facing on roof completed	Mar. 28
Stairs completed in place	Dec. 31, 1929
Floor fill and finish, 8th floor to top, started	Aug. 19
Floor fill and finish, 8th floor to top, completed	Jan. 14, 1930
Furring and plastering, 8th to 57th floor, started	Sept. 16, 1929
Furring and plastering, 8th to 57th floor, completed	Jan. 21, 1930
Toilets, tile and carrara glass, 8th to 57th floor started	Sept. 30, 1929
completed	Jan. 3, 1930
Elevator corridors—marble wainscoting, started	Sept. 24, 1929
completed	Jan. 3, 1930
Elevator corridors—terrazzo floor, started	Oct. 7, 1929
completed	Jan. 12, 1930
Tenant changes started	Dec. 1, 1929
Building completed except for tenant changes	Feb. 1, 1930
First tenant moved in	Mar. 31
Building entirely completed	May 1

Steel Erection—The key to maintaining the construction schedule was to get the steel on the job as required. In order to get started as soon as possible, the steel contract was awarded on the architects' drawings, and the actual steel designing was done by consulting engineers associated with the steel erection contractor. Fabrication was commenced as soon as the steel for the lower floor was designed, and the erection was under way before the steel for the upper floors had been detailed, as is shown in the steel progress schedule, Table II. This table shows that steel shipments were only about ten floors behind and that erection was less than twenty floors behind the completion of shop drawings.

To obtain the speed necessary in fabricating steel for the lower floors, the framework up to the twentieth floor was distributed among five shops. Each floor of the building was divided into areas and the steel for each area was grouped under a shipment number. Expediters at each shop telegraphed daily the shipment numbers that had left the shop that day and the numbers of the cars containing the shipments. Another group of expediters followed the cars through to Jersey

City, where the steel was transferred to lighters and brought to Old Slip in East River. From Old Slip the steel was trucked to the job, each truckload of material being designated for a specific erection derrick. By a system of colored flags, each derrick signaled the trucks waiting in the streets below when to spot the load for hoisting. The design and erection of the steel framework were described in *Engineering News-Record*, May 8, 1930, p. 756.

Handling Other Materials—Many materials other than steel were expedited at the source by the general contractor, including raw material to be delivered to and fabricated by subcontractors, especially for the inclosures of the 45 elevators serving the building, the swinging doors and the bronze and iron work. Because of the narrow streets there was very little storage space available at the site, so most materials had to be brought in

FIG. 2—VIEW OF JOB JUNE 24, 1929

just as required. The first floor, with truck entrances on Wall St., was reserved for the general contractor's material. All subcontractors handled materials from the second floor, which was reached by truck ramps on the Pine St. side.

All concrete and mortar materials were dumped into bins and fed to the mixers by gravity through volume batchers. All mixers were situated so as to dump directly into the tower buckets. From the tower buckets concrete and mortar were dumped into hoppers on every floor and transported to final location by barrows or buggies. There were five mixers used, one for mortar, two for cinder concrete for the floor arches, one for cement floor finish and one for structural concrete.

Hoisting of materials was done by eight exterior and three interior hoists. The exterior hoists, tubular steel towers, were inside of the building as far as the fifth floor, where they broke through the roof at the first setback and continued up the west elevation of the building. Four of these hoists rose to a record height of 763 ft., reaching to the second penthouse, or 62d floor. Two of the other towers reached to the 26th floor, and one each to the 35th and 56th floors. Four of the hoists were operated by 80-hp. motors and four by 60-hp. motors. The following table gives the type and height of the tubular steel hoist towers and the allocation of each:

Tower	Type	Height	Use
A	3-barrow	2d penthouse, 763 ft.	General contractors for masonry
B	Bucket	2d penthouse, 763 ft.	General contractors for masonry
C	2-barrow	2d penthouse, 763 ft.	Masonry and terrazzo tile
D	2-barrow	2d penthouse, 763 ft.	Subcontractors
E	Bucket	56th floor, 697 ft.	General contractors for mortar
F	3-barrow	35th floor, 457 ft.	Subcontractors
G	2-barrow	26th floor, 353 ft.	Subcontractors
H	2-barrow	26th floor, 353 ft.	Subcontractors

All towers were 6 ft. 4 in. square, except the three-barrow, which were 6 ft. 4 in. x 8 ft. in plan.

The subcontractor pouring the cinder concrete floor arches had three interior hoists, two bucket hoists to the 62d and 25th floors and one platform hoist to the 57th floor. Later the bucket hoists were changed to platforms and used by other subcontractors. From the 60th to the 67th floor a relay hoist was installed in one of the elevator shafts. Materials were handled from the 67th floor to the top by a 5-hp. electric motor provided with a niggerhead for a hoist drum. One bay was kept open for the entire height of the building for a hoistway for pipes and conduits, the hoistway being offset to an adjacent bay every twenty stories as a safety precaution.

As fast as the permanent elevators were installed they were used both as man and material hoists. Bricklayers' scaffolds were hung at two levels in the elevator shafts to speed up the inclosing and finishing of the shafts so that they would be available as early as possible.

Elevator service was provided to the highest possible point at all times to minimize the time required by the workmen to reach their jobs.

Co-ordinating Sub-Trades—Fifty subcontractors were associated with the general contractor, not including those specially engaged in tenant change work. Co-ordinating this army of trades into a smooth-working machine operating at top speed was the result of much preliminary study and planning. The schedule shown in Fig. 5 was worked out for the principal sub-trades and was rigidly adhered to in actual construction. Usually on building construction, regular meetings are held for the subcontractors, but this was done away with on the job except for those engaged in installing the elevators. The remaining trades were handled through

TABLE II—STEEL SCHEDULE

Floors	Number of Cols.	Dwgs. to Shop: Cols.	Dwgs. to Shop: Beams	Ship	Deliver	Complete Erection
Grillage	..	....	5 24	6 18	6 22	....
Bsmt.	68					
Mezz. & 1	= 103	5 27	6 3	6 22	6 29	7 6
1-2	35					
2	68	6 3	6 10	6 28	7 5	7 9
2d Mezz. 3	105	6 10	6 17	7 3	7 10	7 13
4-5	103	6 17	6 21	7 8	7 15	7 18
6-7	99	6 1	6 10	7 10	7 17	7 22
8-9	95	6 8	6 17	7 15	7 22	7 24
10-11	95	6 15	6 21	7 17	7 24	7 26
12-13	90	6 24	6 28	7 19	7 26	7 29
14-15	88	6 28	7 5	7 22	7 29	8 1
16-17	88	7 5	7 10	7 25	8 1	8 5
18-19	88	7 10	7 17	7 30	8 6	8 8
20-21	80	6 25	7 12	8 2	8 9	8 12
22-23	80	7 2	7 18	8 6	8 13	8 15
24-25	73	7 9	7 22	8 9	8 16	8 19
26-27	54	7 16	7 25	8 13	8 20	8 22
28-29	54	7 17	7 27	8 16	8 23	8 26
30-31	50	7 22	7 29	8 20	8 27	8 29
32-33	50	7 27	8 3	8 23	8 30	9 2
34-35	50	7 31	8 7	8 26	9 2	9 4
36-37	33	8 3	8 10	8 29	9 5	9 7
38-39	33	8 7	8 14	8 31	9 7	9 11
40-41	33	8 10	8 17	9 5	9 12	9 14
42-43	33	8 14	8 21	9 7	9 14	9 17
44-45	33	8 17	8 24	9 10	9 17	9 19
46-47	33	8 20	8 27	9 13	9 20	9 23
48-49	33	8 23	8 30	9 16	9 23	9 25
50-51	33	8 27	9 3	9 19	9 23	9 27
52-53	33	8 30	9 3	9 20	9 27	9 30
54-55	33	9 4	9 8	9 24	9 30	10 1
56-57	33	9 7	9 14	9 27	10 1	10 3
58-60	..	....	....	....	....	10 11
Balance	..	....	....	....	....	11 12

Note: After 57th floor was reached steelwork slowed down to await favorable weather, as working in high winds was dangerous. Delay on steel did not affect general building schedule.

FIG. 3—VIEW OF JOB JULY 25, WALL ST. IN FOREGROUND

representatives of the general contractor, each representative responsible for one or more subcontractors and for working out systems and schedules for handling materials and keeping the trades up to the general building schedule.

An important factor in keeping the job on schedule was the co-operation of the architects, who usually approved all shop and change drawings within 24 hours of receipt. Frequently the architects were called to the job at midnight to make decisions on matters that were holding up the work.

Tenant Changes—As far as possible the needs of the tenants were provided for in advance. The building, in the heart of the financial district, will have many brokers and financial firms as tenants, requiring special telephone, telegraph and ticker service. Such firms also employ numerous messengers, and an elaborate pneumatic tube system has been installed between all floors and central stations on the basement, mezzanine and second floor mezzanine to eliminate the necessity of the messengers' using the elevators. Risers to provide the electrical and pneumatic services were installed, as the building was erected at points anticipated to provide ample service with as few changes as possible to suit the desires of the tenants. Ventilation ducts were placed in the ceilings of all elevator corridors and can be extended to serve any or all offices on every floor as desired.

As the construction progressed, the following interior finish was completed on each floor: outside walls, elevators, corridors, toilets, interior columns and cement floor finish. The cement floor finish was protected by a covering of rubberoid roofing strips pasted together to form a mat. Wheelbarrows were wheeled across this covering without using planking and caused no damage to the finish.

Tenant changes or the final interior completion of the building did not start until Dec. 1. Not much was done on this work until after the first of the year, as it was held up by failure of most tenants to express their wants and needs. As a preparation to getting started on tenant changes immediately upon receipt of final plans, cement, sand, plaster, tile and stock partitions were stored on various floors. The vast amount of work required by the tenant changes is indicated by the fact that 7,500 lin.ft., nearly 1½ miles, of stock partition, and 1,000 doors for tile partitions were provided for "attic stock" in anticipation of the needs of tenants.

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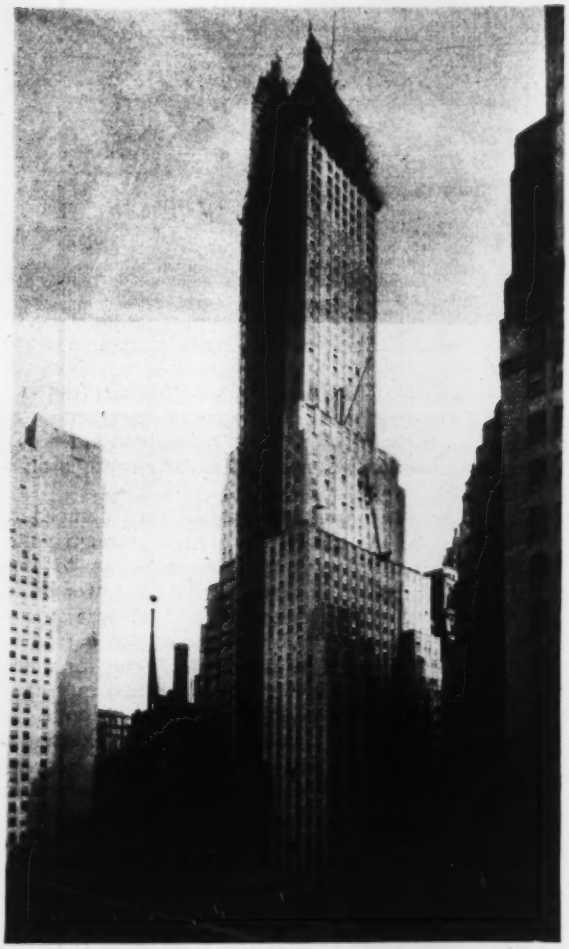

FIG. 4—VIEW, NOV. 7, JUST BEFORE TOPPING OUT STEEL IN PYRAMID ROOF

Wall St. elevation at right. Note tubular steel hoist towers reaching to top of building.

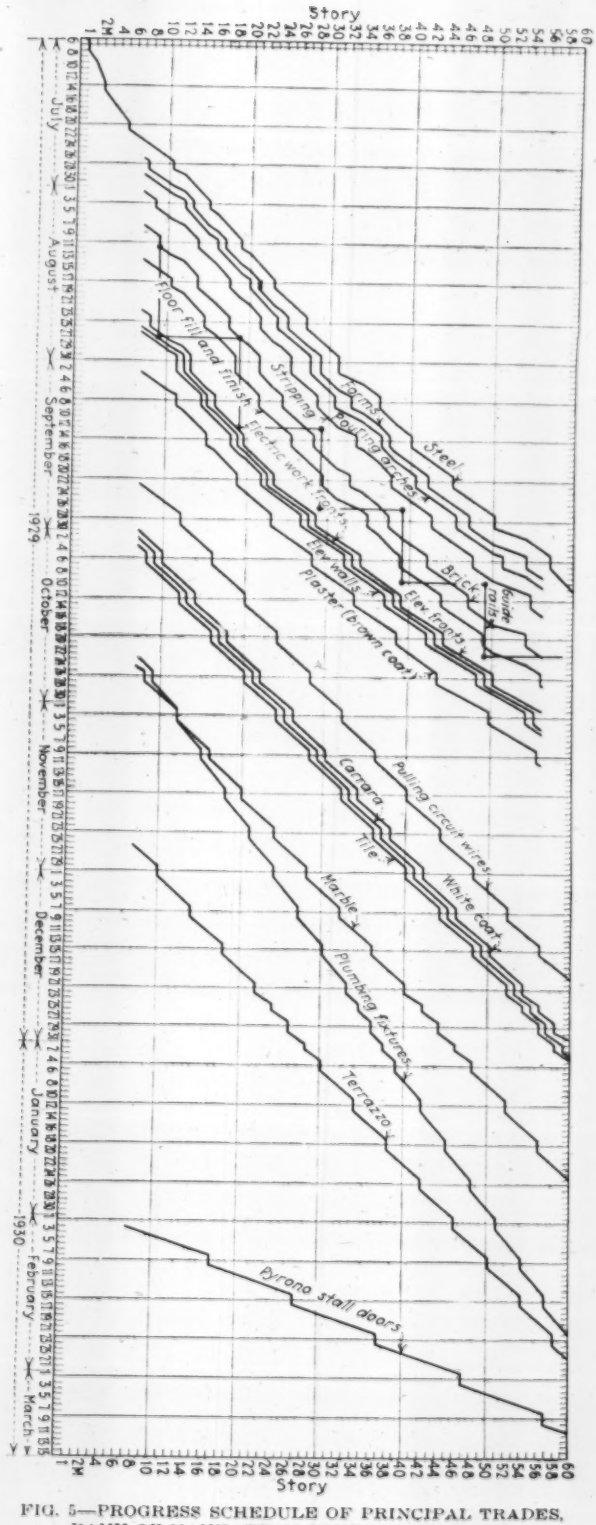

FIG. 5—PROGRESS SCHEDULE OF PRINCIPAL TRADES, BANK OF MANHATTAN COMPANY BUILDING

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New Railway Station at Milan

A NEW passenger terminal now being built at Milan for the Italian State Railways is located outside the main part of the city, as there was no room for adequate enlargement of the present central station. It is of the headhouse or stub-end type, with the main building, 700 ft. long, flanked by two 500-ft. wings parallel with the tracks. There will be 22 platform tracks, with tracks arranged singly between platforms which are alternately 24 ft. wide for passengers and 13 ft. for baggage handling, except that where the roof supports are located the platform widths are 28 ft. and 18 ft. respectively. One platform is only half the length of the others and has a middle or third track beyond it, so that short trains can run to or from this platform while trains are standing at the outer portion of the adjacent long platforms. Five steel arches form the trainshed, which is nearly 1,200 ft. long; a central arch of 240-ft. clear span is flanked by two of 150 ft. and two of 40 ft. The three long spans have arched trusses springing from the platform level, while the two short spans have arched girders supported on columns.

As the track deck and all passenger facilities are above the street level, the first floor is utilized for mail, express and fast-freight service, the freight cars being handled on 45-ton elevators and electric transfer tables. All station tracks connect with a four-track approach, beyond which two main-line routes diverge, six tracks swinging to the left and four to the right, with a double-track line connecting them for switching movements. Within the triangle thus formed is the engine terminal, which has a rectangular engine house with twelve stub tracks. Adjacent to it is a coach yard having nineteen tracks served by a transfer table. Two other coach yards are arranged on opposite sides of the four-track approach. To enable locomotives and fast-freight cars to be moved between the station and the engine terminal and outlying shops and freight yards without occupying the approach tracks, there are connections with two tracks along each side of the layout which pass under the diverging main lines. These tracks are united by a loop within the triangle and are connected also with the two tracks forming the third side of the triangle.

FIG. 3—VIEW OF JOB JULY 25, WALL ST. IN FOREGROUND

representatives of the general contractor, each representative responsible for one or more subcontractors and for working out systems and schedules for handling materials and keeping the trades up to the general building schedule.

An important factor in keeping the job on schedule was the co-operation of the architects, who usually approved all shop and change drawings within 24 hours of receipt. Frequently the architects were called to the job at midnight to make decisions on matters that were holding up the work.

Tenant Changes—As far as possible the needs of the tenants were provided for in advance. The building, in the heart of the financial district, will have many brokers and financial firms as tenants, requiring special telephone, telegraph and ticker service. Such firms also employ numerous messengers, and an elaborate pneumatic tube system has been installed between all floors and central stations on the basement, mezzanine and second floor mezzanine to eliminate the necessity of the messengers' using the elevators. Risers to provide the electrical and pneumatic services were installed, as the building was erected at points anticipated to provide ample service with as few changes as possible to suit the desires of the tenants. Ventilation ducts were placed in the ceilings of all elevator corridors and can be extended to serve any or all offices on every floor as desired.

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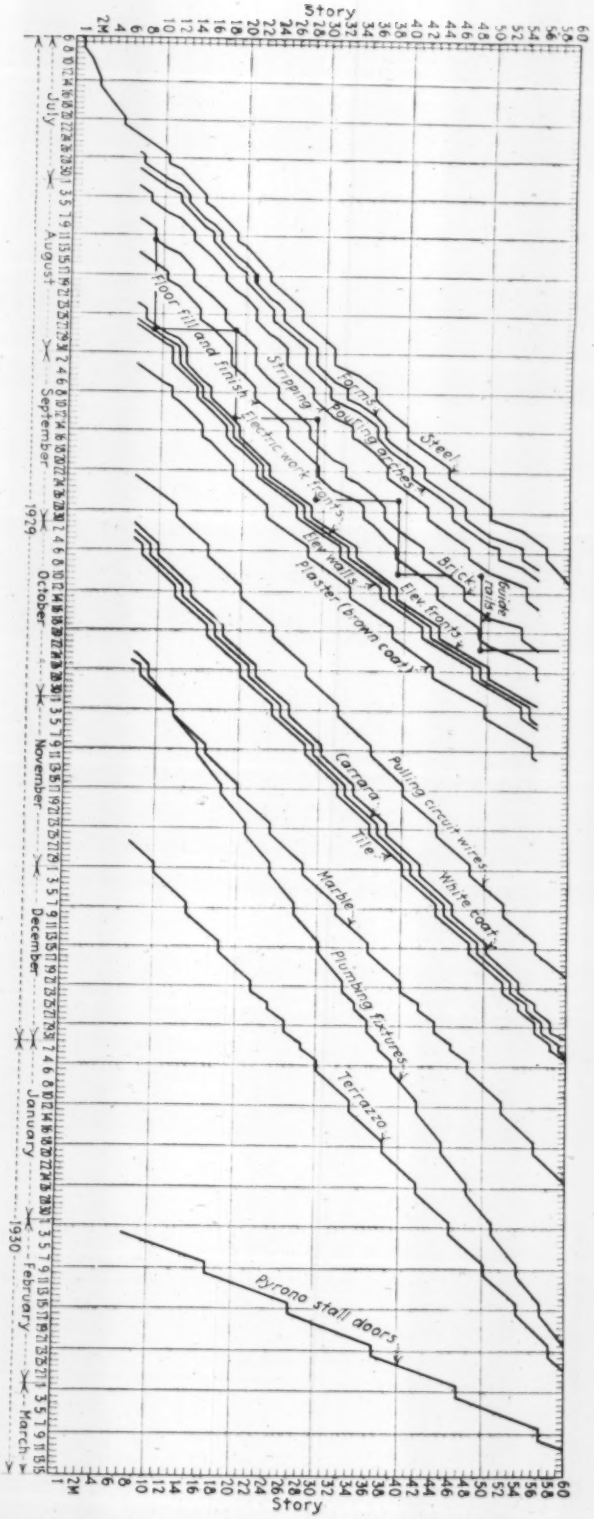

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The 1,200-Ft. Cantilever Bridge at Longview, Wash.

Columbia River Crossing 50 Miles Below Portland, Ore., Completed as Toll Structure After Many Legal Difficulties—Provides 1,100-Ft. Channel With 195-Ft. Vertical Clearance

By Clifford E. Paine
Vice-President, Strauss Engineering Corp., Chicago, Ill.

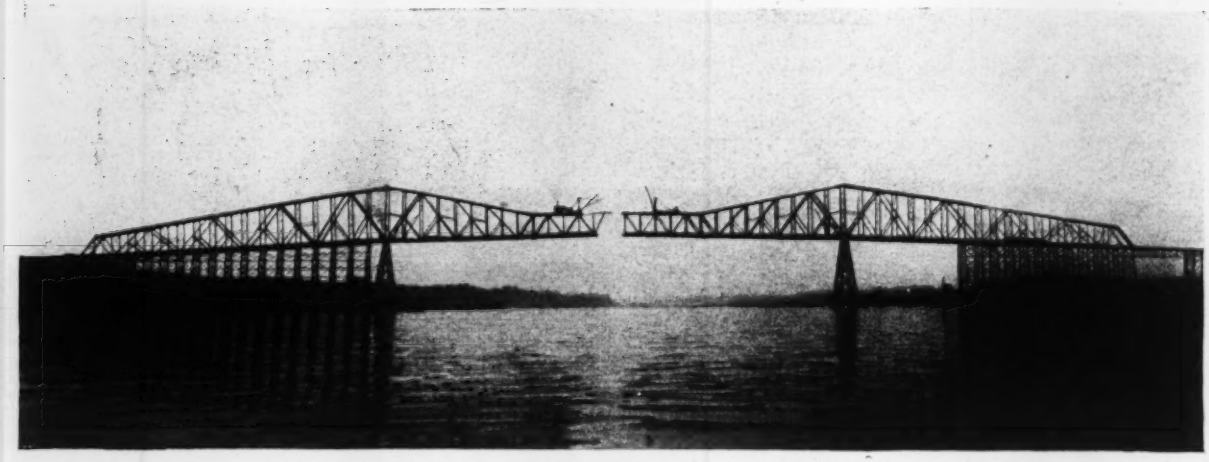


FIG. 1—LAST MOVE OF THE TRAVELERS ERECTING THE 1,200-FT. CANTILEVER SPAN OVER THE COLUMBIA RIVER AT LONGVIEW, WASH.

THE COLUMBIA RIVER Longview bridge, which was opened to traffic on March 29, spans the Columbia River at Longview, Wash., 50 miles below Portland, Ore. It is the longest cantilever structure in the United States, having a main span of 1,200 ft. and anchor arms 760 ft. long. In addition, its clearances above mean low water are unusual—185 ft. at the channel pier and 195 ft. at the center of the main span. A plan and elevation in Fig. 2 give dimensions and indicate the long approaches.

History of Project—Having failed in an effort to have the bridge built jointly by the states of Washington and Oregon, those most interested in the development of the district prevailed upon private interests to promote the enterprise, with the result that W. D. Comer and Wesley Vandercook were granted a franchise in February, 1925. The franchise, however, required that the plans be approved by the highway departments of the states of Washington and Oregon. The highway department of the State of Washington approved the plans. The highway department of the State of Oregon did not approve the plans and the Oregon Legislature passed a bill which restrained the highway department from approving them until they were first approved by the port of Portland. Before this obstacle could be overcome the franchise expired.

A second franchise was obtained by the promoters in January, 1927. Under this franchise, approval by the highway departments of the two states was eliminated and it was stipulated that the plans must be approved by the secretary of war, the secretary of commerce and the secretary of agriculture. After many hearings before the three secretaries and their representatives, a permit to construct the bridge was issued Nov. 3, 1927. The permit stipulated a clear channel width of 1,000 ft. with a minimum vertical clearance of 185 ft. at the channel pier, 195 ft. at the center of the channel, and 155 ft. at the Longview pier-head line. It also stipulated that there should be only one pier between the channel and the Longview pier-head line. In order to meet this latter requirement it was necessary to utilize a main-channel span of 1,200 ft. and to adopt the unusual anchor-arm length of 760 ft.

Foundations

Conditions—Borings indicated a bed of gravel and sand extending more than 100 ft. below mean low water. Overlying this stratum of gravel and sand was a deposit of black basaltic sand of varying depth. The upper surface of the gravel bed was at El. 84.7 below datum on the Washington side (at pier 1, see Fig. 2), from which it sloped upward toward the Oregon side to El. —55 at pier 2, —42 at pier 3 and —32 at pier 4. The depth of water at piers 1, 2, 3 and 4 is approximately 35 ft. at mean low water stage. At a 17-ft. river stage the velocity of the current is 6 miles per hour.

Pier Design and Construction—Pier 1 is carried down to El. —50 where it is founded on piles (20 in. or more at the butt) driven to refusal with an average penetration of 30 ft. The footing is 24 ft. wide, 81 ft. long and 12 ft. deep. Two hundred and sixteen piles were used, and the direct load per pile from dead load plus live load is 22 tons.

From the top of the footing up to El. —2.0, pier 1 consists of two vertical shafts 11½ ft. square connected by a solid diaphragm of concrete which varies uniformly from a thickness of 11½ ft. at the bottom to 6 ft. at the top. Above El. —2.0 the two vertical shafts are extended

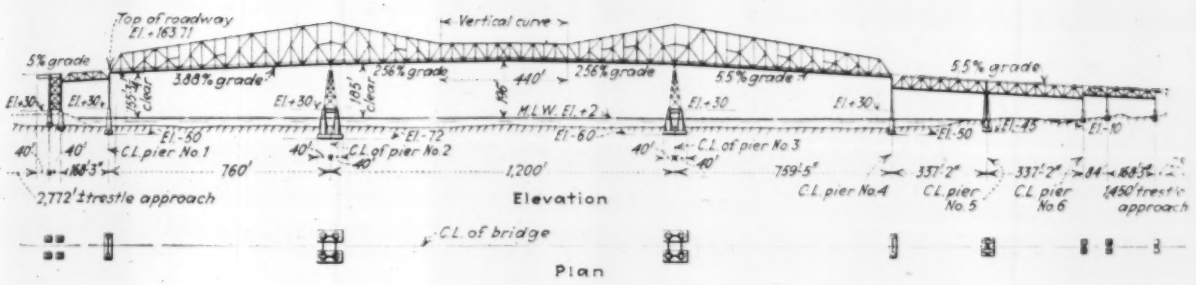


FIG. 2—PLAN AND ELEVATION OF COLUMBIA RIVER-LONGVIEW BRIDGE

upward to El. 30 and are connected at the top with a diaphragm 15 ft. deep and 4 ft. thick. Shafts and diaphragms are heavily reinforced.

For the construction of the portion of the pier below El. —2.0, a crib was built of 12x12-in. timbers tightly bolted together and calked. The inside dimensions of the crib conformed to the outside dimensions of the pier. The crib was built and all reinforcing steel was placed within it at the Pacific Bridge Co.'s dock at Portland, Ore. Excavation for the pier was accomplished by means of a clamshell bucket, after which piles were driven to grade. The crib was floated 50 miles down the river to the bridge site and sunk in place. All openings between the bottom edges of the crib and the excavated hole were carefully closed up with lagging.

A vertical bulkhead separated the crib into two halves, the bulkhead being shaped to provide proper keys for the joint. Concrete for half of the pier, from El. —50 to El. —2.0, was then poured in one continuous operation by means of two 10-in. tremies, which, with their hoppers, were supported directly on the crib. During pouring there was no movement of the tremies except the raising and lowering necessary to control the flow of concrete. As the concrete rose in the crib the shortening of tremies was effected by removing successive sections of the pipe at the upper ends. The upper portion of the pier (from —2.0 to 30.0) was placed in the usual manner.

Pier 4 is similar to pier 1 except that it is founded on the gravel bed with a unit-bearing pressure of less than 3 tons per square foot.

Pier 2 is also founded on gravel but at El. —72.0. It has two footings, each 39x84 ft. with the long dimension parallel to the axis of the bridge. The footings are 16 ft. deep and are spaced 70 ft. c. to c. Each footing carries two vertical shafts 45 ft. apart, having a cruciform section at the base of each arm, which is 33 ft. 4 in. long and 14 ft. wide. The section reduces uniformly to a square 14 ft. on a side which extends from El. —2.0 to 30.0. At the top all four shafts are connected by deep longitudinal and transverse diphragms.

The method of construction of this pier was the same as for pier 1. Separate cribs were made for each footing and a bulkhead was placed so that one shaft and half of one footing were poured as one unit. In this operation four tremies were used within the shaft. On one side of each shaft the crib was built to clear the shaft by 3 ft., and separate forms were provided for that face of the shaft. After completing the pier this well between the crib and the shaft was pumped out, the forms were removed and the surface of the concrete was inspected. Inspections made in this way in six wells on the several piers revealed in every case an excellent grade of concrete.

Pier 3 is similar to pier 2 except that the bottom of the footing is at El. —60.0. It is worthy of mention that although more than 20,000 cu.yd. of tremie concrete was placed, the work was so skillfully handled by the contractor that only once during the whole operation did a tremie lose its charge.

Superstructure

General Design—The bridge carries a 27-ft. roadway and two 3-ft. sidewalks. The trusses of the main bridge and of the 335-ft. approach spans are designed for a live load of 60 lb. per square foot plus impact. The trusses of the shorter deck spans are designed for a live load of 100 lb. per square foot plus impact. The floor system throughout is designed for a live load of two 20-ton trucks on the roadway, plus an impact allowance of 30 per cent.

Silicon steel is used for all main members in rocker bents, towers, trusses and main spans and 335-ft. side

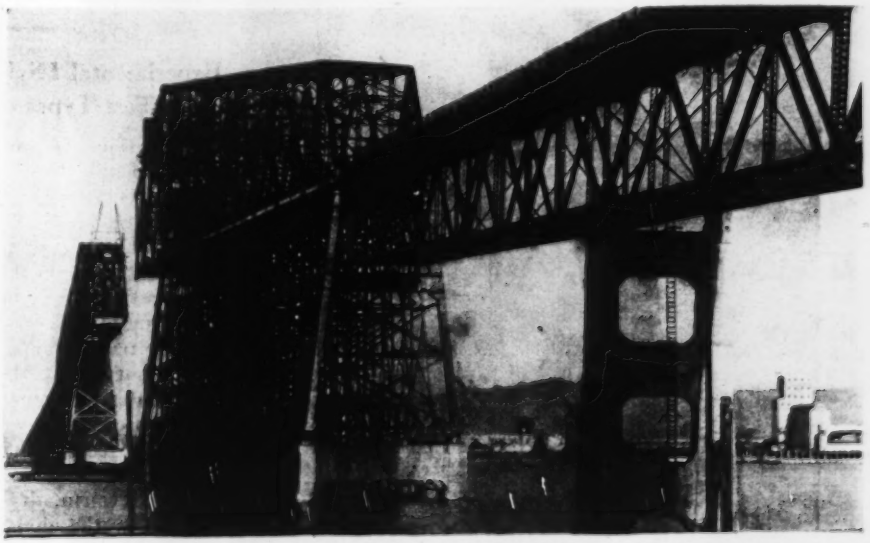


FIG. 3—LONGVIEW BRIDGE PROVIDES 195-FT. VERTICAL CLEARANCE UNDER MAIN SPAN
Note the timber falsework supporting anchor arms.

spans. For this material the unit working stresses adopted were 24,000 lb. per sq.in. in tension, and 22,500-75 l/r lb. per sq.in. in compression. For ordinary structural carbon steel, the unit working stresses employed were 16,000 lb. per sq.in. in tension, and 15,000-50 l/r in compression.

The 760-ft. anchor arms were designed to be self-supporting as simple spans without floor deck. The design provided for erection of the entire 1,200-ft. channel span by the cantilever method with 85-ton stiff-leg derricks working on the top chords.

Erection—The deck truss spans and the anchor arms were erected on falsework and work on the anchor arms proceeded from the shore toward the main towers. Although the anchor arms had been designed as self-supporting spans so that falsework would be necessary for a minimum length of time, no advantage was taken of this, since river conditions were so favorable, and the anchor arms were not swung until after the cantilever arms were completed.

Since the shoes at the top of the main towers (Fig. 4) are fixed, it was necessary to shift the anchor arms in a longitudinal direction in order to make the pin connections between their bottom chords and the shoes. This movement was easily effected by a slight racking of the falsework. The suspended span was cantilevered out an equal distance from each side of the channel. Final closing was effected by means of 500-ton hydraulic jacks placed in the bottom and top chords at the connection of the cantilever arms and the suspended span.

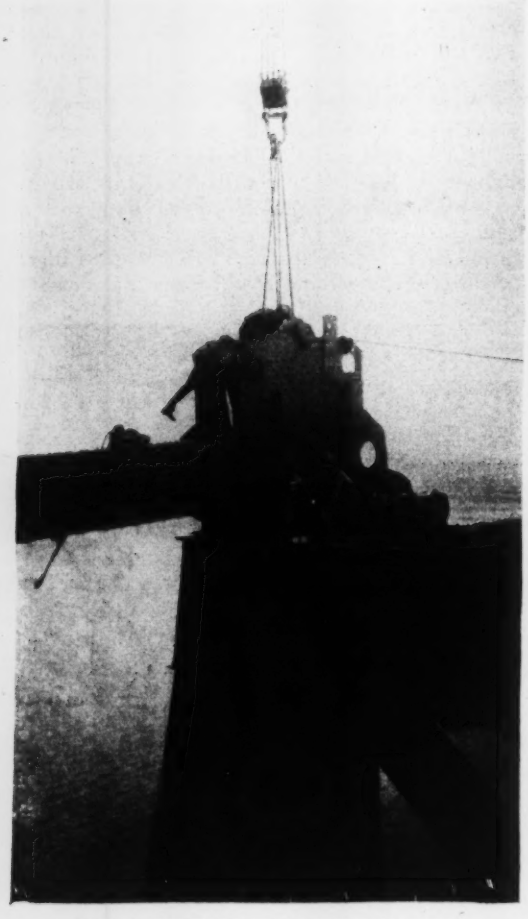


FIG. 4—SETTING MAIN SHOE ON TOP OF TOWER AT PIER 2

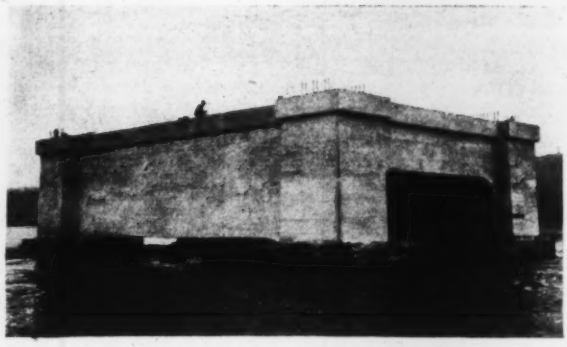


FIG. 3—MAIN CHANNEL PIER COMPLETED, LONGVIEW BRIDGE
Constructed by open crib with tremie-placed concrete

During erection of the suspended span, forms were placed on the anchor arms for the floor deck, and pouring of concrete was started. The floor slab has a total thickness of 6¾ in. and is a 1:1:2 mix of concrete using a lightweight volcanic rock for aggregate, which gave a unit weight of 120 lb. per cubic foot, and physical properties substantially equal to those obtained when using gravel aggregate.

Progress of the Work

General design plans for the project were started in October, 1928, field work began in November, and the bridge was opened to traffic on March 29, 1930—eighteen months after commencement of the general plans. More remarkable than the time record, however, is the record of building a structure of this magnitude without suffering a serious injury to any employee on the work. Approximately 25,000 cu.yd. of concrete and 12,800 tons of structural steel were required in the construction of the bridge.

The Bethlehem Steel Co. was general contractor. The Pacific Bridge Co. was subcontractor for the foundations and J. H. Pomeroy & Co. were subcontractors for steel erection. The Strauss Engineering Corp., as engineer for the Columbia River Longview Bridge Co., made the design and supervised the construction.

Experimental Highway to Be Constructed to Test Types of Low-Cost Surfacing

Construction of an experimental highway, with twenty half-mile lengths of various low-cost oil-treated surfaces, has recently been started under the joint supervision of the U. S. Bureau of Public Roads and the California Division of Highways. The same two organizations will maintain the 10-mile stretch for three years, keeping account of the construction and maintenance cost as well as the service obtained, with a view to obtaining accurate comparative cost data for the various types of surface used. Some sections will be sealed before winter and others will be sealed later, depending on their action under weather and traffic conditions. The test road is located in the mountains near the Nevada line, where the climate includes both severe winter conditions and warm, dry summers. Results of the test, according to the division of highways, should be of value not only to California but also to other states that look to the Bureau of Public Roads for this type of information.

Steel and Iron Work in the Old Waldorf-Astoria Building

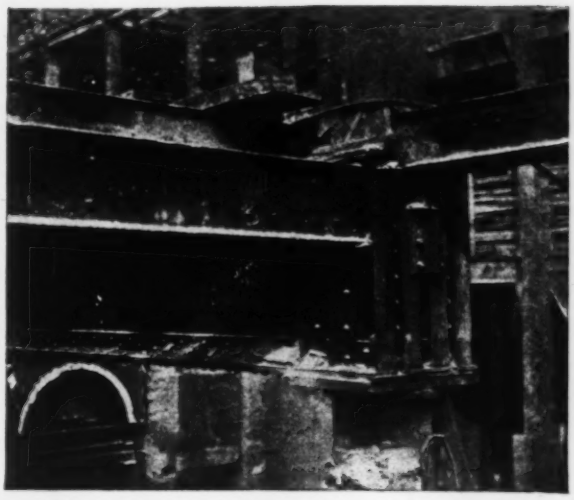
Wrecking of the Structure Discloses That the Metal, Though Erected 40 Years Ago, Had Deteriorated But Little

By F. H. Frankland
Director of Engineering Service, American Institute of Steel Construction, Inc.

IN THE course of wrecking the old Waldorf-Astoria Hotel, at 34th St. and Fifth Ave., New York City, recently, preparatory to constructing the 85-story Empire State Building on the site, some valuable and interesting information was obtained regarding the structural steel and iron work of the old building.

The old structure was built in two parts—the first part on 33d St. and Fifth Ave. in 1891, and the second part at the 34th St. corner in 1895. The general contractors for both structures were John I. Downey & Co., the iron and steel work being furnished and erected by the J. B. & J. M. Cornell Iron Works.

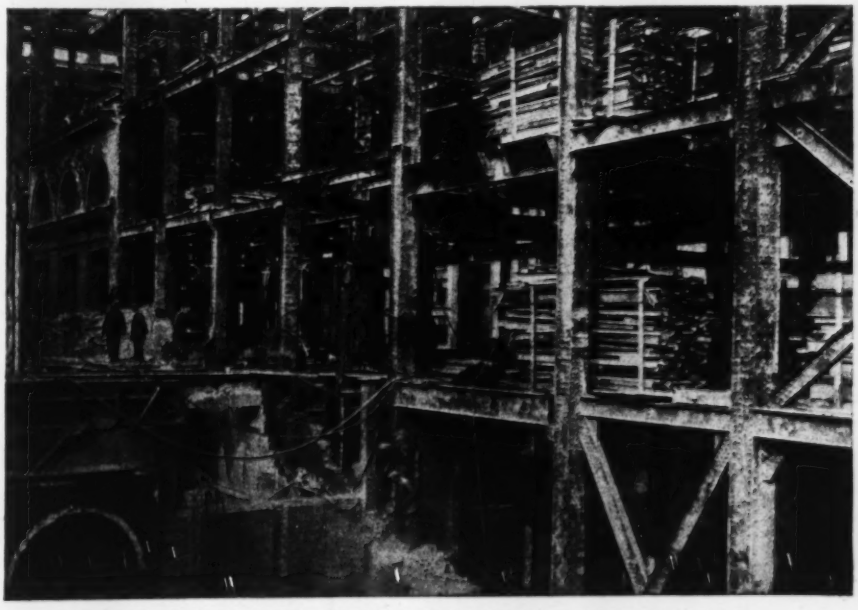
Several careful examinations of the iron and steel work during the wrecking process were made by the writer, from which is was apparent that, in general, the metal was so well preserved that shop markings and stencils were easily readable. One coat of red oxide paint had been applied to the iron and steel of the old building and one coat of black paint to that in the new building, and the only effect of time had been to dull the high gloss of the paint. The only evidence of corrosion found was in four small Z-bar columns in the court where roof leaks had permitted rainwater to enter the interior of the scagliola column incasement, and a careful examination of this rusting showed that less than 1 per cent of the net section had been lost by corrosion, notwithstanding the fact that these columns had probably been saturated with water for many years. The result of these examinations provides convincing evidence that no deterioration of building steel work occurred where protection had been provided, although such protection as the Waldorf-Astoria steel received was not up to the standard of present-day practice. The steelwork of the Tacoma Building, erected in 1887, received one shop coat of linseed oil and was not field-painted, yet a thorough examination by a representative of the American Institute of Steel Construction showed that the shop markings were easily readable and in many cases the gloss on the oil was still intact.



STEEL BOX GIRDER AND CAST-IRON COLUMNS IN OLD BUILDING, ERECTED IN 1891
Steel found in excellent condition. Note sharpness of old stencil marks on girder.

R. H. Shreve, of Shreve, Lamb & Harmon, architects for the Empire State Building, has the following to say regarding materials in the old structure:

> The masonry was of unusually good quality, being sound, strong and with well-filled joints of a much better standard than a great deal of the work executed today. The steel when exposed showed no impairment after 35 to 39 years of service. There were at points slight indications of rust due to moisture introduced with the masonry. There were indications of a single shop coat of paint but no evidence of any protective damp-proof field coat as in common use today but not generally used when the Waldorf-Astoria was erected. Beneath these slight coatings the steel was unmarked by pitting or destruction of the surface. The conclusions to be drawn from an examination of the steelwork of the old Waldorf-Astoria are similar to those which have been advanced by architects and engineers familiar with the use of structural steel in buildings—that is, that no deterioration need be anticipated where the steel is properly protected. In the case of the Waldorf-Astoria protection was obtained through the sound masonry built around the steel, and in present-day practice additional protection is obtained through a shop coat of paint applied before the steel is shipped from the fabricating shop and by an added field coat applied after the steel is erected. In some cases additional protection is sought by pargeting the exterior columns, but this is not necessary if the protecting masonry is properly constructed.



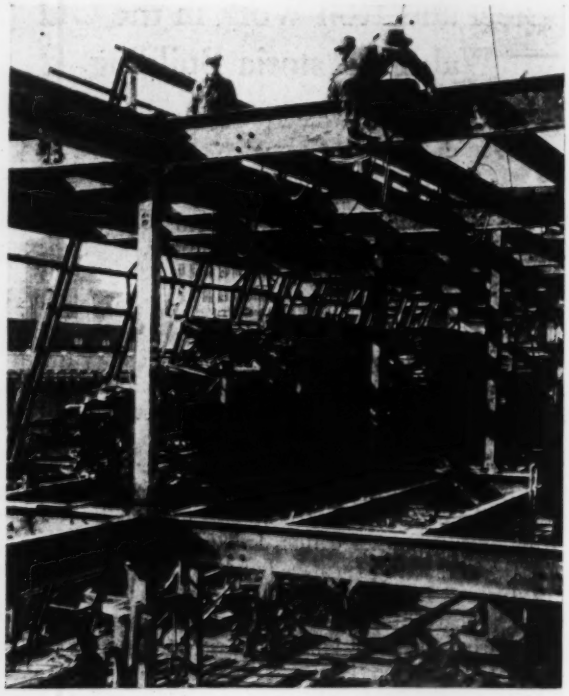
WRECKING THE WALDORF-ASTORIA HOTEL, NEW YORK CITY
South elevation new building, erected 1895. Note substantial crossbracing at right.

Through the courtesy of the general contractor for the Empire State Building, Starrett Brothers & Co., Inc., which wrecked the old buildings, the American Institute of Steel Construction was able to ob-

tain fifteen samples of iron and steel flame-cut from i-beams, flange plates of built-up girders, and various parts of built-up columns. Arrangements were made whereby the assistance and co-operation of F. N. Speller, director of the department of metallurgy and research, National Tube Co., Pittsburgh, Pa., were obtained in having chemical and physical tests made of the fifteen specimens of materials. The table below shows the results of these tests made in the National Tube Co.'s research laboratory under the direction of I. B. McCorkle, director of the laboratory. In the second column of the table, under "Sample Designation," may be seen information concerning the previous history and condition of service of each sample. Hydrochloric acid etching tests indicated that samples 1 and 6 were wrought iron. Most of the remaining samples appeared to be steels, although in three or four cases the etching tests showed laminations similar to those seen in

STEELWORK IN OLD WALDORF-ASTORIA BUILDING ERECTED IN 1891

Original paint marks were plainly distinguishable. View shows bottom chord of trusses over ballroom.



CAST-IRON COLUMNS IN OLD WALDORF-ASTORIA BUILDING

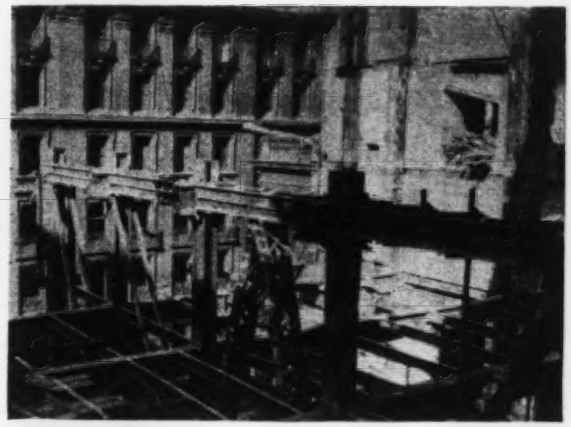
wrought iron, probably due to what would be considered unusually dirty steels according to present-day standards.

The chemical analyses demonstrate definitely that there are but two wrought-iron samples in the group, Nos. 1 and 6 (both from the old building erected in 1891). Of the thirteen steel samples, Nos. 2, 11, 13, 14 and 15 are judged to be of open-hearth origin, and Nos. 3, 4, 5, 7, 8, 9, 10 and 12 of bessemer origin.

The tensile tests were made on 0.400-in. diameter by 2-in. gage length specimens machined from the samples. Their percentage elongations are reported over 1.6-in. gage lengths, this length being geometrically similar to the usual 2x0.500-in. diameter A.S.T.M. specimen. The tensile test results show nothing unusual for the analyses and grades of material under consideration. The impact tests were made using the regular 0.394x0.0394-in. Izod specimen carrying a V-notch 0.079 in. deep. The results seem to show quite a good deal of scatter, but this would be expected on any miscellaneous collection of samples

RESULTS OF TESTS ON SAMPLES FROM OLD WALDORF-ASTORIA BUILDING

Sample No.	Sample Designation	Chemical Analysis					Tensile Properties					
		Car.	Mn.	Sul.	Phos.	Sil.	Yield Point, Lb./Sq.In.	Ultimate Strength, Lb./Sq.In.	Per Cent Elong. Over 1.6 Gage	Per Cent Red of Area	Izod. Impact Strength, Ft.-Lb.	Fatigue Endurance Limit, Lb./Sq.In.
1	15-in. header, Waldorf (old building) 24 ft. 11 in. long, southwest corner, main floor, 33d St. side	0.018	0.07	0.023	0.200	0.110	36,800	51,700	17.5	17.5	20.0	27,000
2	34-ft. 2-in. girder, 27 in. depth, third floor, (Waldorf) (old 33d St. building) S. W. corner 33d St.	.14	.61	.031	.044	.007	39,300	61,600	37.5	62.5	46.5	.....
3	Outside plate, truss column, Astor Court and 33d St., 3 ft. above third floor	.17	.54	.050	.073	.020	32,900	60,800	40.5	61.5	22.4	.....
4	Third floor, Waldorf Building, 33d St.	.14	.66	.076	.076	.026	.....	....	....	....	....	.....
5	Inside plate of truss column, 3 ft. above 3d floor, Waldorf Building, Astor Court and 33d St.	.17	.58	.047	.071	.016	33,500	60,800	39.0	61.5	14.6	.....
6	10-in. floor beam, old Waldorf Building, S.W. cor. 33d St., first floor	.016	.05	.030	.299	.160	34,200	52,600	20.5	23.0	23.1	.....
7	4x4x20-ft., old Waldorf Building, 2d floor, S.W. cor. 33d St.	.16	.73	.082	.086	.020	41,900	66,700	38.0	60.0	27.8	.....
8	From column on 6th floor, Waldorf-Astoria Building	.10	.52	.076	.095	.104	37,900	60,900	30.0	46.0	11.2	.....
9	Part column, 8th floor, 34th St. side	.13	.75	.072	.091	.013	44,600	65,200	36.5	57.5	48.9	.....
10	18-in. header, 2d floor, 34th St. and Fifth Ave.	.14	.53	.061	.095	.010	40,000	62,000	38.0	61.0	7.0	.....
11	20-in. header, 8th floor, west end, 34th St. side	.25	.58	.043	.007	.007	37,500	60,000	35.0	55.0	15.4	.....
12	27-in. girder, 34th St., Fifth Ave. side	.13	.71	.097	.101	.010	50,400	66,000	37.5	58.5	42.7	.....
13	Batter post, outside plates	.28	.46	.034	.014	.008	40,500	65,700	39.5	63.5	38.4	.....
14	Inside plate, batter post	.27	.46	.034	.014	.004	36,800	65,200	39.0	58.5	16.2	.....
15	27-in. girder, 3d floor, Fifth Ave. and 34th St.	.16	.44	.037	.011	.005	36,300	55,000	43.0	68.5	64.7	27,000



TOP CHORD OF TWO-STORY TRUSSES OVER BALL-ROOM IN OLD UNIT OF WALDORF-ASTORIA

varying as much in analysis and method of manufacture as the present ones. Impact tests frequently show very erratic results without the reason for this being apparent from the results of chemical analyses or the usual tensile tests. Fatigue tests were made on one of the steel samples (No. 15) and on one of the wrought-iron samples (No. 1). The results of these tests, as was the case in the tensile tests, show nothing unusual. Both gave endurance limits of 27,000 lb. per square inch, which check nicely with previous results obtained at the National Tube Co.'s research laboratory on modern wrought-iron and modern low-carbon open-hearth steel.

To sum up, it may be said that if due allowance be made for the differences in chemical analyses and in the methods of manufacture the various mechanical tests have given results of about the order which are to be expected from similar materials if manufactured today. This would indicate that there has been no serious deterioration of these metals during the 35 or 40 years of service in the Waldorf-Astoria building.

It is interesting to compare the chemical analyses of the thirteen steel specimens in the table with that of steel removed from the Tacoma Building in Chicago, which was wrecked in 1929 to make way for a modern skyscraper after 42 years of service. The Robert W. Hunt Co. made a chemical analysis of the steel from the Tacoma Building at the request of the American Institute of Steel Construction, with the following result: carbon, 0.12; manganese, 0.40; sulphur, 0.032; phosphorus, 0.063. The acid etching of a polished section of this steel, compared with a similar surface of wrought iron, showed a characteristic steel face and an absence of slag inclusions. It will be noted that this specimen more nearly approaches the analysis of sample 2 than any other of the Waldorf-Astoria steel. Sample 2 showed a yield point of 39,300 lb. per square inch and an ultimate of 61,600 lb. per square inch, and it is therefore reasonable to assume that tensile tests of the Tacoma steel would have shown yield points and ultimate strengths nearly as high as for sample 2.

Clay Linings in Concrete Sewers Range From Arch to Invert

Arch Lined to Resist Gas From Sewage Made Septic by Long Retention—Invert Paved to Resist Erosion by Sediment

LOS ANGELES and Seattle have widely different practices in the lining of trunk sewers. For seven years the practice in the former city has been to protect the arches of concrete sewers with liners of some clay-products material; bare concrete invariably has been used in the invert. Seattle, on the other hand, uses no liners of tile or any other material over concrete arches, but invariably paves the invert with brick. The reasons in both cases, as supplied by the engineering departments of the respective cities, are outlined in the following:

In Los Angeles local conditions result in a decidedly septic condition of the sewage long before it is discharged from the sewer outfalls. This is partly because of the length of the mains (in some cases sewage flows are conveyed in sewers for 50 miles), partly because of temperatures and partly because of the low rainfall with the relatively high percentage of sanitary sewage. Because of the generation of H_2S in the long trunk sewers and the belief that attacks on the concrete would be serious where pockets of this gas would collect, the city considers it advisable to require the use of tile liners in the arches of all large concrete sewers. In some instances sulphur even has been substituted for cement mortar in setting the tile liners in place, thereby to forestall disintegration by gaseous attack of the cement mortar between the tile (*Engineering News-Record*, Sept. 1, 1927, p. 346).

Seattle, on the other hand, has shorter sewers with steeper grades, carrying a more dilute sewage flow and, during storms, a considerable quantity of sharp sediment. The Seattle practice is to pave the invert in all concrete sewers with brick covering an arc of 26.8 per cent of the inside perimeter of the sewer pipe. In depth this equals one-sixth the diameter of the sewer.

Commenting on this practice, W. D. Barkhuff, city engineer, points out that "on account of steep grades and many miles of earth streets, the soil being composed mainly of sand and fine gravel, a large amount of surface material washes into the sewers through the catchbasins and it is not practicable to prevent this sediment from flowing through the sewers." Some of the trunk sewers have velocities greater than 20 ft. per second. Under these conditions considerable wear on the invert is expected. "If this scour wears away the invert," Mr. Barkhuff continues, "the sewage flow can be temporarily diverted, a new brick paving laid and thus leave the sewer in as good condition as when originally constructed." No exact information is available on the amount of wear on the brick inverts. Requirements for the brick used in this service are that they must show an ultimate compressive strength of 12,000 lb. per square inch and an absorption less than 3 per cent by weight in 76 hours.

As to danger of gas attack on the arches of Seattle sewers, an inspection of about 15 miles of trunk and main sewer lines was made in 1922, Mr. Barkhuff reports, without revealing any notable deterioration of concrete that could be attributed to gas attack; this despite the fact that for more than 90 per cent of the year the depth of flow in the trunk and main sewers does not greatly exceed one-sixth of the diameter. Some of the sewers inspected were then 28 years old and the average age was about ten years.

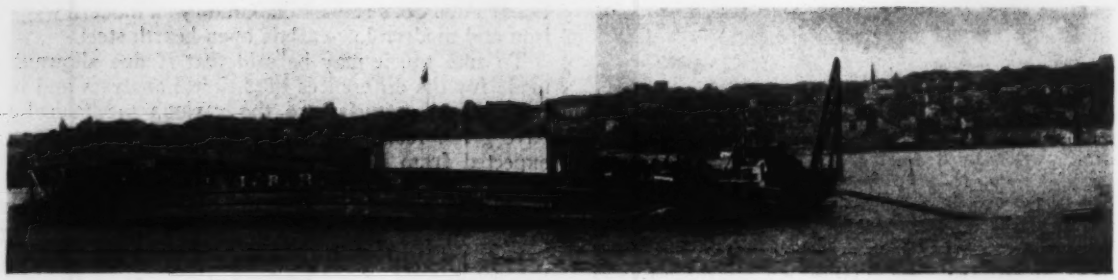


Fig. 1—Barge Used in Laying High-Pressure Gas Line Across Hudson River

High-Pressure Gas Line Laid Across Hudson River in Fast Time by Unusual Methods

6,520 Ft. of 8-In. Pipe Placed on River Bottom in Eleven Days and Seven Hours—Long Car Float Used as Working Barge—Pontoons Prevent Excessive Strains in Pipe—Welded Sleeve Joints Used

By H. C. Sandbeck

Structural Engineer, Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y.

INTERESTING and unusual construction methods were used in laying 6,520 ft. of 8-in. high-pressure gas line across the Hudson River between Beacon and Newburgh, N. Y., in eleven days and seven hours. The pipe, assembled and lowered from a long car float, was kept to proper curvature, avoiding undue stresses, by means of pontoons attached to the pipe and later released as bottom was reached. Special welded sleeve joints were developed for this work. The river crossing is part of a 19-mile high-pressure line built by the Central Hudson Gas & Electric Corp. between Poughkeepsie and Newburgh.

The distance across the river at the pipe crossing is 6,300 ft., and the depth of the water varies between 20 and 50 ft. Tide currents as high as 5 miles per hour, rough water due to high winds, and interference of considerable river traffic all had to be taken into consideration. Lump sum bids were asked for laying the pipe, but prices received were all considered too high, and it was therefore decided to award the contract on a cost-plus basis.

Preliminary Preparations—A car float 280 ft. long and 33 ft. wide was hired for a construction barge and a supply of pipe sufficient for the entire crossing was taken on board (Fig. 1). The pipe used was 8-in. extra-strong steel pipe, weighing 43 lb. per foot, delivered in 40-ft. lengths and loaded on the barge by a steam crane. For the laying operations two 40-ft. pieces were welded together on board and the pipe was handled in 80-ft. units. After the welded joint had been tested and the pipe given the specified coating, the 80-ft. lengths were stacked on both sides near the bow of the barge. Along the center line of the barge from bow to stern were erected a series of rollers to carry the pipe as it was welded, tested and laid out. The last roller at the stern was set as close to the deck as possible and the rest of the rollers were elevated a maximum of 8 ft. to form a smooth curve of the pipe, which ended in a 200-ft. straight horizontal run. A 5-ton truck equipped with a 12-ton winch was taken on board to move the pipe, and two floating piledrivers were used to lay out anchors and to move the barge.

Welded Pipe Joints—After several types of pipe joints in common use had been considered and rejected, a novel joint was devised by T. A. Corby, superintendent of construction, Central Hudson Gas & Electric Corp. This joint, shown in Fig. 5, consists of a butt weld reinforced by a short sleeve of 9-in. standard pipe which fits over the joint and is welded to the pipe at both ends. Important advantages of this design are that two out of three welds must be faulty before the pipe leaks and also that the pipe has a considerably greater factor of safety against excessive laying stresses at the joint than along the pipe itself. Theoretically this may seem of little value, but by watching the actual conditions under which a job like this is carried out it is clearly realized that this feature carries with it a great assurance. The greatest benefit obtained by this joint, however, is the time and trouble saving in testing the joint.

Testing the Joint—Each of the 9-in. pipe sleeves was

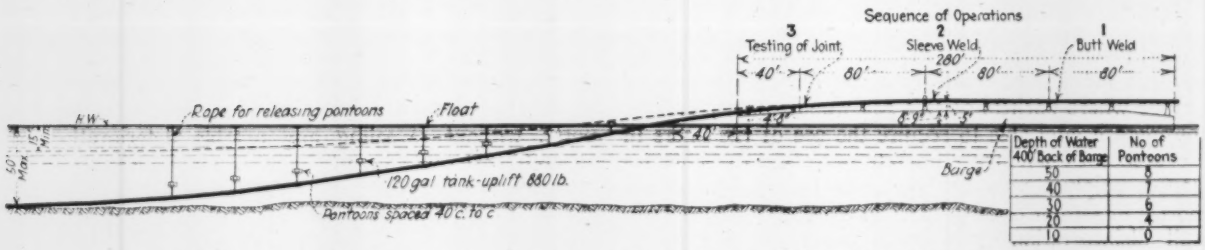


FIG. 2—PROFILE OF LINE AND CONSTRUCTION BARGE, SHOWING USE OF PONTOONS TO ELIMINATE EXCESSIVE STRAINS IN PIPE AS IT IS LOWERED

provided with a hole threaded for $\frac{1}{8}$-in. pipe. To this tap was attached a pressure gage and a valve connected to a cylinder of compressed nitrogen, this gas being used to obviate any danger of an explosive mixture. The nitrogen entered the $\frac{5}{32}$-in. space between the inside of the sleeve and the outside of the pipe, which had a volume of about $\frac{1}{10}$ cu.ft., at a pressure of 350 lb. per sq.in. Soapsuds were put around the sleeve welds to detect any leakage on the outside (Fig. 6). If the pressure dropped and no leak in the sleeve welds could be detected, the center butt weld obviously was faulty and the pipe was cut and rewelded. This, however, did not happen during the actual laying of the pipe. It can easily be realized what a saving of time and effort this method of testing effected compared with pumping up the whole pipe. Only nine cylinders of nitrogen were required in testing 163 joints.

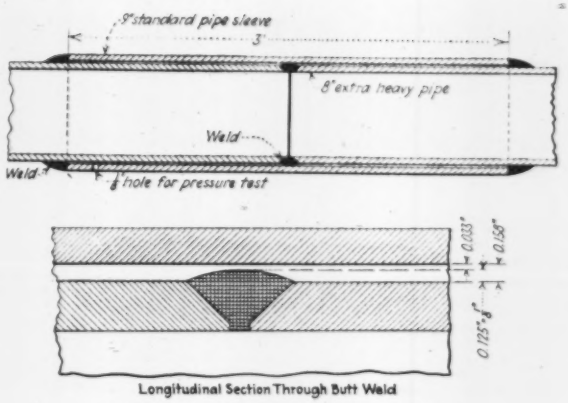


FIG. 5—DETAILS OF WELDED BUTT AND SLEEVE JOINT

Laying the Pipe—The river on both sides was dredged to a depth of 20 ft. below high water before any pipe was placed. The barge was then brought close to the shore and the first length of pipe pushed out so that about 10 ft. of it remained above water, and the shore end of the pipe was sealed by welding and fastened to the shore. As the pipe was fed out from the barge it deflected considerably, but the deflection was checked by attaching pontoons as shown in Figs. 2 and 4. The pontoons, arranged to reduced the effective weight of the pipe to about $\frac{1}{2}$ lb. per foot, followed the pipe down to the river bottom as the line was lowered, the pontoons being released by the use of the hook shown in Fig. 7 after bottom was reached. Laying proceeded on a 24-hour schedule. Butt welds were made near the bow of the barge, the sleeve was simultaneously welded up about midships and at the same time the joint was tested near the stern. When these three operations were finished, 80 ft. of pipe was laid out and a new length started at the bow.

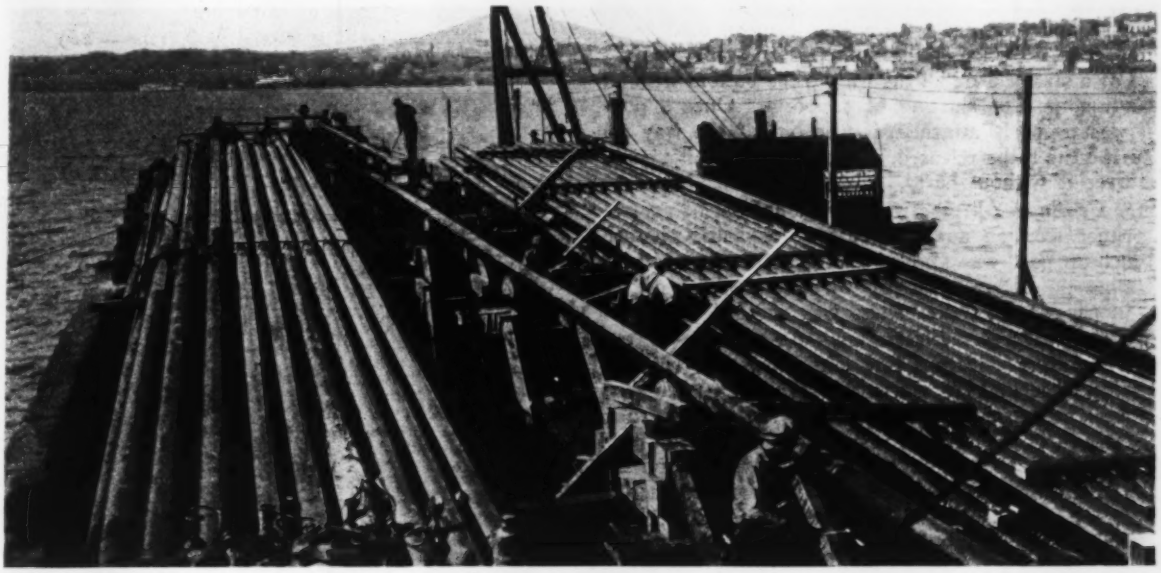


FIG. 3—VIEW OF ONE END OF CONSTRUCTION BARGE
Man in foreground is welding sleeve joint. Eighty-foot length of pipe being rolled into position at far end of barge.

FIG. 4—ONE OF THE PONTOONS READY TO GO DOWN WITH PIPE

Welding and testing required about $1\frac{1}{4}$ hours, and the shifting of the barge under average conditions took about 45 minutes, so 800 to 950 ft. of pipe was laid per 24-hour day when no mishap occurred. The task of moving the large barge along a given line, with the tide and wind conditions encountered, required expert seamanship. Six anchors held the barge in place, and more were held in reserve for use when wind and tide became dangerously strong. A windstorm followed by rain and rough water held up the operations on two occasions, delaying the job a total of 40 hours. In spite of these delays the crossing was completed in eleven days and seven hours, with a maximum 24-hour run of 960 ft.

At the beginning of the job it was found that the pull required to release the pontoon hooks was surprisingly great, the pulling rope breaking on some of

FIG. 6—TESTING WELDED JOINT
Nitrogen at 350-lb. pressure used. Soapsuds on sleeve welds detect leakage on outside, and loss of pressure on gage indicates leakage in inside butt weld.

the pontoons, requiring the services of a diver to cut them loose. The hooks were then straightened as shown in Fig. 7 and provided with a ¼-in. samson cord for a pulling rope. By using the pontoons the pipe was assured of a steady drop all the way to the bottom without any adjustment or shifting of supports. Once a pontoon was properly attached, it was out of the way till its turn came to be released, and light river traffic could pass over it without harm.

Pipe Coating—All pipe was given one coat of asphaltic primer solution and one coat of asphaltic enamel. A touch-up coat was applied as the pipe was fed out. By lining the rollers with rope or felt cracking of the coat in passing over the rollers was avoided.

Protection Against Electrolysis—As a result of experience with a 4-in. gas line laid across the river at the same place in 1925 which developed bad pitting on a portion in the river due to electrolysis, an insulation joint, shown in Fig. 8, was installed in the line on each side of the river 15 ft. out from high-water line on the bank. Furthermore, the pipe was incased in concrete 100 ft. on the shore end from the water-line. The electrolysis previously experienced was probably caused by stray currents from an electric street railway and was checked by the installation of insulating joints in 1927.

Analyzing the Laying Stresses in the Pipe—The first problem to present itself in connection with the laying of the pipe was to determine what kind of a curve the line would follow and the magnitude of the stresses in the pipe when it was laid out from the barge to the river bottom 20 to 50 ft. below. As no information could be found covering this particular problem, the writer had to develop formulas mathematically. The formulas and their derivation are given below, and can be used for any size of pipe laid down to any depth.

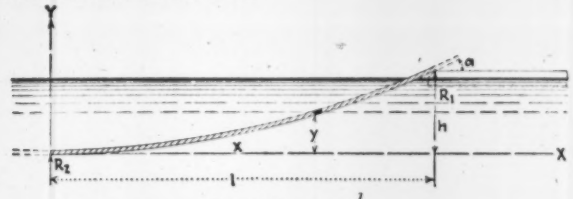
Nomenclature

R_1 and R_2 = Reactions caused by the suspended portion of the pipe.
M_x = Bending moment at a point (x, y).
w = Average weight of the submerged pipe per unit length.
E = Coefficient of elasticity.
I = Moment of inertia of pipe.
r = Outside radius of pipe.
l = Horizontal distance between the point of support on the barge and the point where the pipe touches the bottom.
h = Vertical distance between the point of support on the barge and the point where the pipe touches the bottom.
f_s = Bending stresses in the pipe.
a = Angle between pipe and the horizontal at the point of support on the barge.

NOTE: Use the same unit dimension of length (for instance inches) throughout.

Assumptions

1. It is assumed that there is no horizontal reaction on the pipe at the points of support. (The barge neither pulls nor pushes on the pipe.)
2. It is assumed that the bottom is horizontal where the pipe touches.
3. The fact that a small portion of the pipe is above water and therefore weighs more than w per unit length is disregarded.
4. It is assumed that there is no horizontal load on the pipe, caused for instance by streaming water. Stresses caused by such loads can be calculated as for a fixed beam and the resultant stresses determined as usual.



$$R_1 = R_2 = w\,\frac{l}{2}$$

$$M_x = R_1\,(l - x) - w\,(l - x)\,\frac{l - x}{2} = \frac{w}{2}(lx - x^2)$$

$$\frac{M_x}{E\,I} = \frac{d^2y}{dx^2} = \frac{w}{2\,E\,I}\,(lx - x^2)$$

$$y = \frac{w}{2\,EI}\iint (lx - x^2)\,dxdx = \frac{1}{24}\,\frac{w}{EI}\,(2lx^3 - x^4 + C_1x + C_2)$$

when

$$x = 0,\ y = 0 \text{ and } y' = 0$$

therefore

$$C_1 = 0 \text{ and } C_2 = 0$$

1. $$y = \frac{1}{24}\,\frac{w}{EI}\,(2lx^3 - x^4);\quad y' = \frac{1}{12}\,\frac{w}{EI}\,(3lx^2 - 2x^3)$$

when

$$x = l,\ y = h$$

from 1,

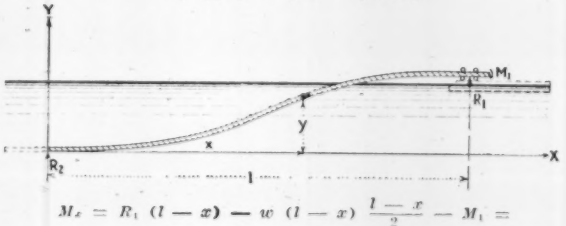
$$l = \sqrt[4]{\frac{24\ h\ EI}{w}}$$

2. $$M\ max = \frac{w\,l^2}{8} = \frac{w}{8}\sqrt{\frac{24h\ EI}{w}} = \frac{1}{4}\sqrt{6}\,\sqrt{w\,h\,EI}$$

3. $$f_s\ max = \frac{Mr}{I} = 0.613r\sqrt{\frac{w\,h\,E}{I}}$$

when $x = l,\ y' = \tan a$

4. $$\tan a = \frac{1}{12}\,\frac{w}{EI}\,l^3 = \frac{1}{12}\,\frac{w}{EI}\sqrt[4]{\left(\frac{24\,h\,E\,I}{w}\right)^3}$$
$$= \sqrt[4]{\frac{24^3\,h^3\,E^3\,I^3\,w^4}{12^4\,E^4\,I^4\,w^2}} = \sqrt[4]{\frac{2\,h^3\,w}{3\,E\,I}}$$



$$M_x = R_1\,(l - x) - w\,(l - x)\,\frac{l - x}{2} - M_1 =$$
$$-\frac{w}{2}\,x^2 + (wl - R_1)\,x + R_1l - \frac{w}{2}\,l^2 - M_1$$

$$\frac{d^2y}{dx^2} = \frac{M_x}{E\,I} \quad \therefore E\,I\,y = \iint M_x dxdx = -\frac{w}{2} \times \frac{1}{3} \times \frac{1}{4}\,x^4$$
$$+ (wl + R)\,\frac{1}{2} \times \frac{1}{3}\,x^3 + \frac{1}{2}\,R_1\,lx^2 -$$
$$\frac{w}{2}\,l^2\,\frac{1}{2}\,x^2 - \frac{1}{2}\,M_1x^2 + C_1x + C_2$$

when $x = 0,\ y = 0$; therefore $C_2 = 0$
when $x = 0,\ y' = 0$; therefore $C_1 = 0$

$$EI \times y = -\frac{w}{24}\,x^4 + \frac{1}{6}\,(wl - R_1)\,x^3 + \frac{1}{4}(2\,R_1l - wl^2 - 2M_1)\,x^2$$

and

5. $$R_1l - wl\,\frac{l}{2} - M_1 = 0;\ \text{therefore } M_1 = R_1l - \frac{w}{2}\,l^2$$

6. $$E\,I \times y = -\frac{w}{24}\,x^4 + \frac{1}{6}\,(wl - R_1)\,x^3$$

7. $$E\,I \times y' = -\frac{1}{6}\,w\,x^3 + \frac{1}{2}\,(w\,l - R_1)\,x^2$$

from 7

when $x = l,\ y' = 0$; therefore $\frac{1}{3}\,w\,l^3 - \frac{1}{2}\,R_1\,l^2 = 0$

$$R_1 = \frac{2}{3}\,w\,l. \qquad \text{Point of infl. } x_1 = \frac{2}{3}\,l$$

from 5

5a. $$M_1 = \frac{1}{6}\,w\,l^2. \qquad M_2\ max = \frac{1}{18}\,w\,l^2 = \frac{1}{3}\,M_1$$

When $x = l,\ y = h$,

therefore from 6

$$-\frac{w}{24}\,l^4 + \frac{1}{6}\,w\,l^4 - \frac{1}{9}\,w\,l^4 = h\,E\,I$$
$$\frac{1}{72}\,w\,l^4 = h\,E\,I$$

8. $$l = \sqrt[4]{\frac{72\ h\ E\ I}{w}}$$

9. $$f_s\ max = \frac{r}{I}\ M_1 = r\sqrt{2}\ \sqrt{\frac{w\ h\ E}{l}}$$ from 5a.

10. $$M_1 = \frac{1}{6}\ w\frac{72\ h\ E\ I}{w} = \sqrt{2\ w\ h\ E\ I}$$

General Conclusions

1. If w is decreased, l is increased, but f_s and a are decreased.
2. If the size of the pipe is increased f_s is decreased.
3. If h is increased, l, f_s and a are increased.

The formulas were checked by experiments with ½-in. gas pipe and the following deductions were made for an 8-in. pipe sunk to 50 ft.: (1) If the pipe were left unrestrained on the barge as indicated in the upper drawing, it would touch the river bottom 196 ft. out from the barge and it would form an angle with the horizontal at the barge of 27 deg., which, of course, would be very impractical. Furthermore, the maximum stresses in the pipe would be 43,000 lb. per sq.in. (2) If the pipe were laid out horizontally from the barge, it would touch the bottom 258 ft. out and the maximum stresses in the pipe would be 98,000 lb. per sq.in.

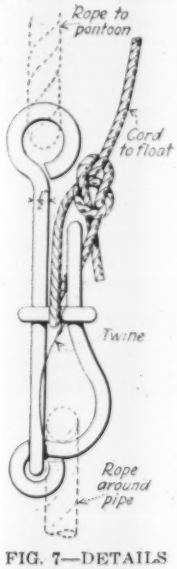


FIG. 7—DETAILS OF TRIP HOOK

It may be claimed that pipe lines have been laid down under similar conditions without rupture, but what obviously happens is that the pipe bends as soon as the elastic limit of the material is exceeded. The pipe is thereby weakened mechanically and the resistance to the flow of gas is permanently increased. By considering the formulas for the maximum stresses in the pipe, it was seen that the laying stresses in the pipe could be kept within safe limits by decreasing the weight of the pipe in the water. This condition was obtained by the use of pontoons, as already described.

Cost of the Work—Detailed material and labor costs of the work are given in the accompanying table.

The job was carried out under the direct supervision of T. A. Corby, of the Central Hudson Gas & Electric Corp. The L. E. Myers Construction Co., Inc., New York, was contractor, with R. T. Hyland in charge. The moving of the barge was done by William Parrot's Sons, engineers and dockbuilders, Newburgh, N. Y.

Central Hudson Gas & Electric Corp. Expense			
6,520 ft. 8-in. extra heavy pipe	$9,388.25		
163 pcs. 9-in. standard pipe 3 ft. long	1,319.44		
65 gal. bitumastic and 9,000 lb. enamel	518.75		
44 iron drums (pontoons)	170.00		
50 light bulbs	21.45		
Miscellaneous	63.65		
		$11,481.54	
C.H.G. & E. engineering and inspection		1,387.14	
			$12,868.68
Contractors' Expense			
Trench work east and west shore	$250.00		
Dredging east and west side of river	3,000.00		
Preparation of barge, labor and material	2,122.03		
Navigating the barge across river	3,800.00		
Welding, testing and laying pipe	4,850.00		
Pipe coating, material and labor	1,109.00		
Rental of barge	750.00		
Rental of lighting plant	288.40		
Services of diver	200.00		
Rental of launch	511.41		
Welding material and gas	1,527.00		
Compensation and public liabilities	615.08		
Rope, anchors and canvas	900.00		
Superintendence and office expense	500.00		
Hardware, drilling sleeves and tools	1,002.55		
Gas and oil	126.94		
Pontoons	242.00		
Lumber on barge	797.43		
Hotel and boarding expenses	901.70		
		$23,493.54	
12 per cent contractor's fee		2,819.22	
			$26,312.76
Total cost of job			$39,181.44

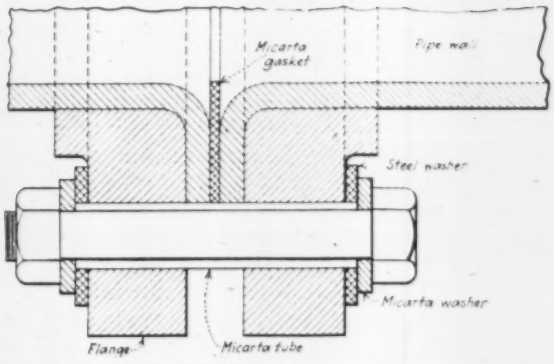


FIG. 8—HALF LONGITUDINAL SECTION OF INSULATED JOINT USED TO CHECK ELECTROLYSIS

Budgeting Improvements on the Kansas City Southern Railway

Expenditures Controlled by Annual Budgets Based on Programs Covering Terms of Several Years

MUCH has been heard of the advantages of the budget system in regulating expenditures, and a striking example of the application of this system, with its economic and practical results, is given in the accompanying abstract of a paper read before the Railroad Business Association by C. E. Johnston, president (and former chief engineer) of the Kansas City Southern Railway. —EDITOR.

THE system now in use on the Kansas City Southern Railway for the budgeting of maintenance and improvement work was begun about 1907, when a comprehensive report was rendered the management by the late H. G. Burt, consulting engineer. This report led to a bond issue which provided funds for essentially rebuilding the property. The work included grade reduction, involving considerable change of line, the relocation of engine terminals and the general rehabilitation of the property. As this extensive work called for heavy expenditures, not all the recommended work could be financed at once. The report, however, formed the first program for improvements, and this original program, devised some 22 years ago, is still one of the definite aims toward which the railroad is working.

Programs for Improvements—For systematic development, programs spread over terms of several years are the underlying basis of the annual budgets, which cover individual items of work. Important items are considered individually and a period of five to ten years is selected over which additions, improvements or replacements are spread, careful attention being given to the probable sequence of work, the need for which may exist or may be only anticipated. These programs are prepared by the interested departments, usually under

the guidance of consulting advice, and carry general estimates of cost. They are submitted to the management and the executive officers and become recognized as general plans for the guidance of future recommendations, but do not carry any definite authority to proceed with work. They cover, in more or less detail, improvements to and the purchase and replacement of locomotives, cars, shop machinery, rails, ballast, bridges, stations and many smaller items.

Budgets—Budgets are divided into two classes, one of which deals with additions and betterments, involving capital charges. The other covers only maintenance. In the latter part of the year the chief engineer and the superintendent of machinery prepare for their own and allied departments a preliminary budget which embraces new work recommended and unfinished work already under way which will incur charges in the succeeding year. This preliminary budget shows the cost of the proposed work, divided as to additions and betterments, maintenance and stock. It is worked down until the charges to capital account are compatible with available funds when the final budget is submitted for approval.

However, approval of the budget is the approval only of the total amount shown as charged to investment and means only that this amount can be expended. Since many items incur heavy maintenance charges, it is important that consideration be given to these items in the maintenance budget. Again, when emergency work is undertaken, it has to be submitted for one or more items approved on the budget in order to protect the integrity of the total charge to investment.

Budgets for maintenance of way and maintenance of equipment are also prepared on an annual basis and are interwoven with the improvement budget to provide sufficient funds for maintenance work incidental to the betterment work. The maintenance work in both the road and equipment departments is scheduled with the purpose of avoiding disturbing fluctuations in working forces and of keeping the expenditures more or less uniform throughout the year. The method by which this is accomplished is the equalization of some accounts each month without respect to the actual work performed. The two principal accounts in which this is done are rail and ties. At the end of each year all equalized accounts are adjusted to reflect the actual work chargeable to them.

A budget is nothing more or less than an approved and adapted plan of procedure for which the funds have been appropriated. The carrying out of the budget requires constant and careful supervision. It is of almost equal importance that all the money appropriated be applied to the property and that no more than that amount be approved to be expended. This requires a careful follow-up system and reports come to the management at stated intervals showing the exact status of work performed and money expended. This is as important as any phase of either programming or budgeting, for the effectiveness of any plan is in its execution and never in its conception.

Repair Shops—Under the general improvement program undertaken in 1907, the principal locomotive and car shops, located at Pittsburg, Kan., and Shreveport, La., were improved and enlarged to provide approximately twice as much capacity as the traffic at that time required. But in approximately ten years the surplus capacity was exhausted. The management then started the preparation of an elaborate program for the further enlargement of the Pittsburg shops, and arranged this program to cover a three-year period in some items and in others a five-year period. Thus the large expenditure for this extension was absorbed so gradually that it was met entirely from available funds without hardship. No machine more than ten years old was left in that shop when any improvement in that particular machine had been made. It was found to be of material advantage to have the shop equipped with modern machines and tools. The machines thus replaced either were sent to shops of lesser importance, where they could be used advantageously, or were sold or scrapped.

Track—For rail renewals, the approximate amount of rail required was determined, in order that a constant annual renewal of that amount would provide a uniform condition of rail on the entire system. This program has been in effect for more than fifteen years, in which time the road has not been burdened with unduly heavy renewals in any one period. For ballasting, a program for a definite minimum thickness of ballast under the tie was spread over a period of about eight years.

Bridges—Similarly, a program covering bridge work was devised and carried out. It included the elimination of many short trestles by permanent structures of various kinds, as well as the strengthening of certain metal bridges not strong enough for heavy engines, together with the entire rebuilding of several major structures such as the bridge over the Arkansas River.

Railway Stations—Improvement of passenger stations was undertaken in the same way by careful programming. Important agricultural or industrial areas were first separated from the mill towns and lumber camps which depended upon temporary conditions for their prosperity. These permanent towns were then programmed for substantial stations, with the program arranged in such a way that about ten years would be consumed in its completion. The original sequence was often disturbed by influence or authority which had to be regarded, but in general this work has gone on, and is still going on, in accordance with the program.

Transportation Budget—The budgeting of transportation expenses has not yet been carried to any systematized conclusion. At least one other road has done this successfully, and it is being studied. A large portion of transportation expense varies almost directly with the tonnage offered for movement, and this portion would have to depend entirely upon traffic conditions, regardless of any budgeting. However, the elements of transportation, such as fuel consumption, overtime and trainload are given careful scrutiny.

Value of Budgeting—In conducting any business, be it a manufacturing plant or a railroad, its success is dependent upon the relationship between earnings and expenses. Some positive current record must be always available in a business as complicated as a railroad; otherwise expenses may mount to the point where drastic curtailment is the only salvation. Drastic curtailment is most objectionable. It demoralizes working forces during its enforcement and incurs the heavy expense of training new men when ended. Worse than that, it allows property to deteriorate expensively, requiring greater expenditures to make deferred maintenance effective. The budget system, well planned and carefully supervised, eliminates disturbing fluctuations in the large maintenance accounts, stabilizes working forces and provides, at short intervals, a reliable index of the relationship of earnings to expenses.

Four Large Water-Filtration Plants Proposed for Chicago

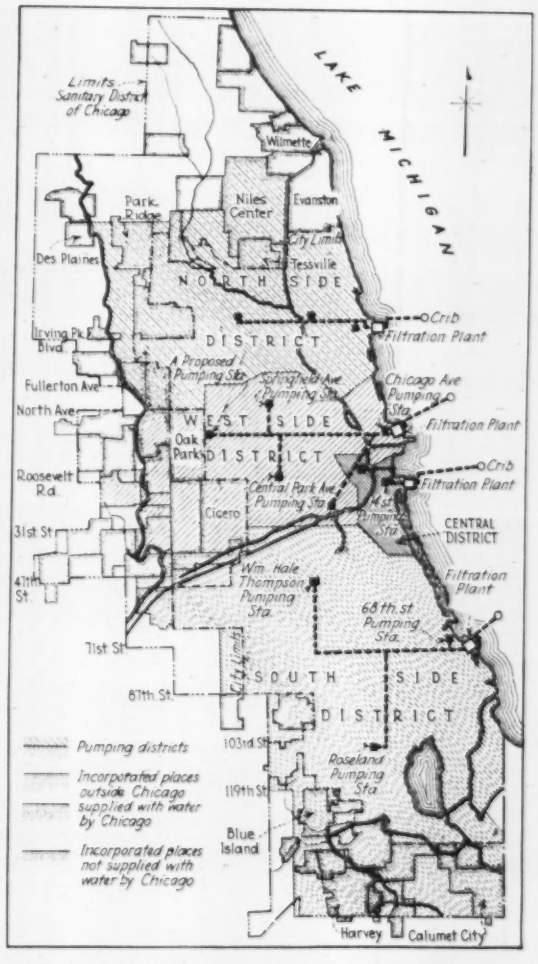
FOUR water-filtration plants to supply Chicago and the other municipalities it serves are proposed in tentative plans recently outlined by Loran D. Gayton, city engineer, in an address before the Western Society of Engineers. At the same time Mr. Gayton summarized the leading conclusions drawn from two years' operation of the Chicago experimental filtration plant. The four plants (see map) would serve as many water-supply districts through a dozen pumping plants. The capacities are based on estimated peak loads for an unmetered distribution system. Most of the pumping stations are already in service. The estimated cost to serve the present population is $60,000,000.

The filtration plants would be in units consisting of mixing and settling basins of 55-minute and of four-hour detention capacity, sedimentation in two stages, sand and activated-carbon filters of 144-m.g.d. capacity at an operating rate 125 m.g.d.; and 10 m.g. of clear water storage per unit.

The main facts brought out by the work of the Chicago experimental filter plant and studies of the design division, as stated by Mr. Gayton in the address already mentioned were:

Lake Michigan water may be made perfectly potable and clear by filtration at a cost similar to that incurred in other cities. Water containing micro-organisms in abundance may be handled without difficulty. There are no uncertainties, since the chemicals and equipment used are not new. A practical method of completely eliminating taste-producing compounds by activated carbon has been perfected. A method for handling highly polluted water has been developed. The most desirable method of treatment will partly soften the water, saving soap to the extent of $750,000 annually. The cost of filtration will not exceed $1 per capita per year and it would cost the citizens ten times as much to buy spring water for actual drinking purposes (¼ gal. daily) as to filter the entire supply. Based on an initial outlay of $60,000,000, sinking fund, operation and maintenance charges would add only 2c. a gallon to the cost of supplying water. This could be met by increasing the present low rate of 6½c. per 1,000 gal. to only 8½c.

Aluminum sulphate produces excellent clarification, but when micro-organisms are abundant the filter runs are too short for the practical and efficient operation of a large plant. Ferrous sulphate and lime give good results and produce runs within the bounds of what may be considered satisfactory practice. Chlorinated iron and lime, a treatment just developed for water, although perfected some time ago by the Sanitary District of Chicago in the conditioning of sewage sludge, produces excellent results and gives filter runs long enough for the practical operation of a large plant. Superchlorination followed by dechlorination with activated carbon removes all objectionable taste-producing compounds likely to occur in Lake Michigan water, and there seems to be enough of these obnoxious tastes that may not be removed by aeration to justify the treatment indicated. Attempts to shorten the usual settling period in the colder months have not been successful and limits have been established. However, rates of filtration in excess of those customarily practiced may be used and the reduced construction cost in consequence will more than pay the cost of the experimental work. This is not considered a major consideration, however. Mixing time of at least 45 minutes has been established as necessary to produce the most efficient results.



LOCATION OF PROPOSED WATER FILTERS FOR CHICAGO AND DISTRICTS TO BE SERVED

Water from four filtration plants on the lake front will be delivered to four pumping districts covering the whole of Chicago and a considerable outside area, the latter mostly within the Sanitary District of Chicago. Boundaries of incorporated places within or mostly within the Sanitary District are indicated by symbols, one kind denoting places supplied by Chicago and another those having either their own supplies or else supplies from an outside municipality other than Chicago—as Wilmette from Evanston.

The filtration experiments have been made by John R. Baylis, filtration engineer. A. H. Marshall, filtration design engineer, working under the general direction of O. B. Carlisle, engineer in charge of design, reporting to Mr. Gayton, has worked out the preliminary designs for the filtration plant units. An elaborate "picture layout" of filters for Chicago was presented several years ago by the late John Ericson, then city engineer, Mr. Gayton then being in charge of designs.

New York Central Four-Tracking Work —*Correction*

On page 642 of the April 17, 1930, issue, in the article describing the four-tracking work being done by the New York Central Railroad, the length of the lift bridge under construction across Wappinger Bay was erroneously given as 85 ft. This structure will be 40 ft. clear span between fenders.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

A Regrettable Omission

UNFORTUNATELY the name of the author of "Bridges: A Study of Their Art, Science and Evolution, Illustrated With Photographs and Drawings of Old and New Bridges in Many Lands," was omitted from the notice of the book that appeared in this section April 17, 1930, p. 661. The author is Charles S. Whitney. A typographical error led to giving the number of pages of the book as 36 instead of 366, but this error was made evident by the statement that the book contained "400 illustrations, mostly halftone views." The book is published at $20 by William Edwin Rudge, 475 Fifth Ave., New York City.

Civil Engineers' Handbook Revised

AMERICAN CIVIL ENGINEERS' HANDBOOK—Editor-in-Chief, Thaddeus Merriman; Associate Editor-in-Chief, Thomas H. Wiggin. Fifth Edition, thoroughly revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall. Flexible; 4½x7 in.; pp. 2263; line cuts and tables. $8—or in two volumes, $10.

REVIEWED BY CLINTON L. BOGERT
Consulting Engineer, New York City

ALTHOUGH the late Mansfield Merriman produced twoscore books and monographs, he is best memorialized by the American Civil Engineers' Handbook which is known to most of us as "Merriman." During his life, Professor Merriman saw his Handbook go to four editions and achieve an authoritative standing. The fifth edition, under the dual editorship of Thaddeus Merriman and Thomas H. Wiggin, has been rearranged, revised and reset. The result bears witness to the energetic scholarship of these two well-known civil engineers, their typographical taste and lively appreciation of the needs of the practicing engineer. They have been ably assisted by 41 associates (constituting an impressive list of names), of whom 23 are practicing and ten teaching engineers, and eight are physicists and chemists. Breed, Douglas, Williams, Hazen, Woodward and Maurer have co-operated through the vicissitudes of five editions. The editors newly associated in this edition are Thaddeus Merriman, Wiggin, Eddy, Hayden, McCarthy and Souder.

The first impression of the new edition is its typographical comeliness. Legibility has been improved by a better spacing of words, by center headings in larger type, by tables in clearer type and by a liberal use of boldface in paragraph headings and in the text. Headings of tables and many formulas and symbols are in boldface. A page-by-page inspection of the new edition shows continued improvements. There are 307 more pages. Of the 15 per cent increase, 5 per cent is absorbed by the wider spacing of words and headings.

Much new material has been added. Committee reports of the A.S.C.E., A.S.T.M. and A.R.E.A. have been more freely drawn on than in previous editions. The chief new material comprises: pumping costs; motor starters; selection of motors; ventilation of motors; repetitive and impact stresses; oblique flexure of beams; welding; Begg's models; secondary stresses; Mill's flow formula; red water troubles; irrigation water losses; subsidence of muck.

Among the topics revised are: cost data; specific heat; boilers; steam consumption; steam turbines; diesel engines; corrosion of metals; structural shapes; bridge piers; rainfall averages; filter washing; water consumption; water rights; reclamation laws; port developments; economics of railroad location.

The old sections which have been assigned new authors require brief mention. Physics is by Wilmer Souder, physicist, Bureau of Standards, together with seven bureau experts. New matter includes temperature and temperature scales, temperature-measuring equipment, thermal insulation, humidity, protection against lightning; wind pressure on structures.

Foundations and Earthwork is by Walter J. Douglas. The works of Terzaghi and of the A.S.C.E. soil committee are given prominence. Concrete and Reinforced Concrete is by Arthur G. Hayden. It represents the latest practice. The design of beams and flat slabs is treated fully. Shear, diagonal tension and bond are presented clearly. Enough is not given on retaining walls, culverts and covered reservoirs.

Sewerage, by Metcalf & Eddy, is full of practical matter. The discussion of sludge quantities is new and valuable. Reference to segmental-block sewers and the use of liner-plates should have been included. Garbage, also by Metcalf & Eddy, is succinct but sufficient for a handbook. Highways, by J. S. Crandell, is an excellent presentation; sixteen well-selected figures show standard pavement and sidewalk cross-sections.

The index has been prepared by Arthur R. Holbrook. It appears complete and of less parsimonious phraseology than is usual in such work. It is unfortunate that space would not allow an index by name of all the structures described in the book.

The reviewer holds that each specialist consults a handbook not for his own specialty, but to get a working understanding of the fields of other specialists. This theory should influence the editorial policy in the allocation of space. An earlier reviewer complained that McKibben's section on Steel Structures was too complete for the non-specialist, and insufficient for the bridge engineer. On this principle, too much space may have been used by the physicist's description of temperature measurements, by Hayden's theory for the Westchester Parkway bridges, by domes of masonry, by sand ejectors, and by specifications of the A.S.T.M. for cement, concrete aggregates, reinforcing steel and metal test specimens.

Specialties of civil engineering omitted for lack of space include airports, sewer trenches, valuation of public utilities, reinforced-concrete standpipes, geology, stadiums, earthquakes, underpinning, city planning, parks and swimming pools. There is a sparsity of references to collateral reading. The direct value of many references is lessened by not mentioning the year; in the changing arts the recentness of an authority is important.

To limit each expert to his proper field is difficult. Disconcerting duplications and lack of agreement result in scores of cases. Professor Goodenough says (p. 348)

1 hp.-hr. = 2,546 B.t.u. and Mr. Parry says it is 2,544 (p. 309). Overlapping texts occur on turbines, internal combustion engines, steam consumption, bearing powers of foundations, earthwork classification and haul, oblique beams and elastic arches.

The shortcomings of the new edition are chiefly minor. All readers agree that the perfect handbook has yet to be compiled. Some minor errors of the earlier editions have been corrected; others persist. Not all of the criticisms made in past reviews have been met in this edition. However, it is a long step ahead of the fourth edition, and will prove of great value as a ready reference. The editors have done a notable service to the profession. The new "Merriman" will continue to be an authority.

Previous reviews are given in *Engineering News*, Feb. 16, 1911; Jan. 16, 1913; May 18, 1916; *Engineering Record*, Feb. 18, 1911; *Engineering News-Record*, March 18, 1920.

Many-Sided Utility Questions

MATERIALS FOR THE STUDY OF PUBLIC UTILITY ECONOMICS—By Herbert B. Dorau, Associate Professor of Economics in the School of Commerce, Northwestern University, and Research Associate in the Institute for Research in Land Economics and Public Utilities. New York: The Macmillan Co. Cloth; 5½x8½ in.; pp. 975; charts and tables. $5.

THE fact that nearly a thousand printed pages are filled with excerpts, mostly short, from writings on various aspects of utility economics is an indication of the voluminous literature on the subject and the invitation for making excerpts from it thus afforded.

The joint compiler and editor does not state directly for whom he intended the excerpts. In his brief preface he urges the need of a better understanding of public utility problems, both by the public and by those managing utilities. He seeks to justify an exhibit of "many and wide differences of opinion" in "undigested and controversial form" because of the "present disturbed state of the public mind" on public utilities, as though such an undigested mass would not add to the disturbance and confusion. His assumption to the contrary may be taken as an indication of the class for whom the book is intended and as a tribute to their judicial capacity.

The aim of the compiler was, the preface states, to present "in so far as possible, all sides of important subjects." This ideal, the author states, in many instances was far from realized due to the absolute lack or very indifferent character of material representing one point of view or another." In trying to strike a balance in such cases "obviously superior material was discarded" in favor of variety in point of view. Which the compiler thinks are weak places in the excerpts he leaves for his readers to decide as best they may—with one notable exception. Excerpts from a well-known lately deceased strong advocate of municipal ownership have cautionary notes by the editor at two or three points. As these are almost the only editorial notes of any kind in the book, absolutely none appearing in connection with at least one sweeping allegation that municipal ownership is a failure, they seem to reflect a bias in favor of private ownership.

The excerpts are grouped under eighteen chapter heads, such as development of the Public Service Industries, Organization, Legal Status, Regulation, Cost of Service, the Labor Factor, Taxation, Valuation, Rate of Return, Ownership. Altogether there are 179 excerpts, averaging between 5 and 6 pp. in length. Commendable features of the book are 87 charts, diagrams and an index of 24 pp.

For those who are able to do their own digesting or who study the book as a school reading course under professorial guidance and comment, the book should be highly useful. For others it is likely to add to the existing confusion over mooted utility questions, but even for those, if not too close minded, it will indicate that most of the questions at issue have at least two sides.

Deflection Measurements on Dams

REVIEWED BY FRED A. NOETZLI

Consulting Hydraulic Engineer, Los Angeles, Calif.

DEFORMATIONSMESSUNGEN AN STAUMAUERN: nach den Methoden der Geodäsie. Im Auftrage der Abteilung für Landestopographie des Eidgenössischen militärdepartements—Von W. Lang. Bern, Switzerland: Service Topographic Federal. Paper; 8x11½ in.; pp. 58; 64 illustrations, including maps and graphs. 6 francs.

THE precise measurement of the deflections of dams is a difficult problem. Despite the enormous forces involved when a high storage dam is subjected to the pressure of a full reservoir, the deflections are relatively small, varying from practically nothing at the foundation of the dam usually to less than an inch near the crest. In the Stevenson Creek test dam the deflections were measured with marked success by means of clinometers. For service dams 200 to 300 ft. high, this method is difficult and expensive, mainly on account of the scaffolding which is necessary for the observers.

When recently some high dams were built in Switzerland, the government topographic institute was called upon to measure the deflections of these structures by triangulation with direction theodolites, as used in the geodetic survey of the country. Observations were made on two dams of the single-arch type, one curved and two straight gravity dams, and one arch of a multiple-arch dam. Mr. Lang was in charge of most of the field work and of the working up of the data. His description of the initial difficulties in obtaining a sufficient degree of accuracy and reliability of the data will be of interest to those who may wish to use this method for similar purposes. He calls attention particularly to the importance of a most careful selection of the triangulation points, including sights for establishing the displacement of the instrument stations themselves, in case such displacement should occur, as was indeed observed on several of the Swiss dams.

The author describes an ingeniously simple method for determining in a semi-graphical way the movements of the targets on the dams from the theodolite observations. The accuracy of the observations was about ±1.0 second of arc. On some dams this corresponds to an accuracy of 0.1 mm. (0.004 in.) of the linear deflections. Credit is given to H. Zoelly, chief of the geodetic division, for suggesting the triangulation method and demonstrating its accuracy for measuring the deflection of dams.

The book contains numerous deflection curves of points in the middle of the dams and in other vertical sections on both sides thereof. On several of the dams there were observed permanent displacements after the first filling and emptying of the reservoirs.

An account is further given of the observation of vertical displacements of dams. It was found that such displacements are independent of the load on the dams and are apparently due entirely to changes of temperatures.

The author stresses the desirability of a periodical observation of important dams by accurate triangulation methods, as these methods might be used better than any other known method for determining movements of

dams due to displacements of the bedrock from seismic or other influences.

The remarkable degree of accuracy of the deflection measurements on these Swiss dams by the triangulation method is well evidenced by the smoothness of the deflection lines. No attempt was made to interpret the deflections in terms of strains and stresses, as this was considered outside the province of the engineers of the topographic institute. Nevertheless, the book contains most interesting data and should be of value to all engineers connected with the design and construction of concrete dams.

Encyclopedia Supplement Revised

THE NEW INTERNATIONAL ENCYCLOPEDIA: Supplement. Vols. I and II. New York: Dodd, Mead & Co. Cloth; 7x10 in.; pp. 1818, in both volumes; illustrated. $20.

IN THESE rapidly changing times how to keep an encyclopedia up to date on the one hand and on the other how to possess an up-to-date encyclopedia are problems for publishers and purchasers alike. A large percentage of the material presented in any standard encyclopedia does not need frequent and extensive revision, but much is left that soon becomes woefully inadequate. Consequently much of the investment in an encyclopedia must be scrapped by publisher and user alike whenever a general revision is made.

One way of meeting the problem is to lengthen the period between wholesale revisions by issuing supplementary volumes. This was done in 1924 in the case of the New International Encyclopedia, which had been overhauled in 1914. Now the two-volume supplement has itself been revised. These supplementary volumes, combined with the annual known as the International Year Book, issued by the same publishers, do all that can be reasonably expected in the way of revised and new material, short of revising the whole work every year, which would be as impracticable for purchasers as for users.

The careful attention given to engineering and other technical subjects by the International since its inception has been continued in the new revision of the supplement. Department main topics and contributors that may be noted are: Civil Engineering, Prof. James K. Finch, Columbia University; Electrical Engineering, Prof. Walter I. Slichter, Columbia University; Tractors, R. W. Trullinger, U. S. Department of Agriculture; Railways, William E. Hooper, formerly with the *Railway Age;* Power Engineering, Alfred D. Blake, associate editor of *Power;* Sanitary Engineering and Municipal Government, M. N. Baker, associate editor, *Engineering News-Record;* American and European Cities, Mary Clapp.

Traffic for the St. Lawrence

THE FUTURE MOVEMENT OF IRON ORE and Coal in Relation to the St. Lawrence Waterway—By Fayette S. Warner, C.E., M.B.A., Ph.D., Political Science Department, University of Pennsylvania. Philadelphia: University of Pennsylvania Press. Cloth; 6x9 in.; pp. 195; line cuts, tables and folding maps. $3.

RECONSTRUCTION of the St. Lawrence waterway for deep-draft vessels cannot be justified unless it can be shown that there will be traffic enough to warrant the expenditure of the large sum involved. Working from this premise, the author, Fayette F. Warner, has selected two of the major bulk commodities which might be expected to move from the Great Lakes to the Atlantic Ocean by way of the St. Lawrence River and has prepared an analysis of the future sources and possible movements of these commodities.

As a result of his studies, Mr. Warner believes that there will develop a large movement of both coal and iron ore through the St. Lawrence waterway in the future, provided the waterway is made available to larger vessels than can now navigate that channel. Exhaustion of the high-grade iron ore reserves of the Lake Superior region and exhaustion of the British coal reserves in the not-far-distant future is taken by Mr. Warner as the basis for his conclusion that construction of the deep-draft canal is warranted. Opening the St. Lawrence to all types of oceangoing vessels would make it possible for high-grade iron ore to be brought in for the supply of the steel plants in the Lake Erie district as the Lake Superior ore becomes exhausted. At the present rate of consumption, he states, the relatively rich iron ore deposits of the Lake Superior district will be exhausted in the next twenty years and consequently the importation of high-grade foreign ore, especially from South America, will still be taken into consideration. With coal available for the return trip, even though no other commodities were available, the importation of ore by the St. Lawrence route becomes highly attractive.

In conclusion Mr. Warner states that the potential tonnage of all kinds of freight for the St. Lawrence route, which at present are moving through more costly avenues of commerce, ranges from 20 to 30 million tons, and that in spite of the obsolete equipment and adverse circumstances of operation of the present route nearly 8,000,000 tons passed over it in 1927, an increase of 600 per cent during the last 25 years.

Terms Peculiar to Transportation

A TRANSPORTATION GLOSSARY for Students: Terms and Phrases in Common Usage in Air, Highway, Railroad and Ocean Transportation and in Port Traffic—By H. G. Brady, A.B., Instructor in Transportation in the School of Commerce, New York University; M.Am.Assoc. of Port Authorities, Soc. of Terminal Engineers. New York: Simmons-Boardman Publishing Co. Flexible; 5x7 in.; pp. 105. $1.75.

THIS little book is an attempt to bring together for the convenience of students definitions of terms and phrases in common use in air, highway, railroad and ocean transportation. In its present form it has numerous errors and some questionable definitions. With careful revisions after it has been reviewed by the men of long experience in the several fields served by the book, it should provide a convenient glossary for those unfamiliar with the subjects covered.

State Safety Regulations Tabulated

SAFE PRACTICES PAMPHLET NO. 94—Reprinted from *National Safety News*, March, 1930. Paper; 8½x11 in.; pp. 8; tables. Free, from National Safety Council, Civic Opera Building, 20 N. Wacker Drive, Chicago.

INDUSTRIAL safety requirements of all the individual states is the subject of No. 94 of the series of safe practices pamphlets published by the National Safety Council in Chicago. The need and purpose of this pamphlet is summarized in the opening paragraph: "Practically every state in the United States has in force certain safety requirements for industry which employers in that state must follow. Every employer should familiarize himself with the requirements for his operation. He can do this by studying the state publications, which may be secured by writing the proper authorities of his state. The National Safety Council receives so

many inquiries from its members on this subject that this pamphlet has been prepared, not to quote these requirements in detail but to help the employer secure state publications and to study the requirements."

The pamphlet contains a chart listing 84 common subjects on which various states have safety industrial requirements, indicating which of the states have requirements for each subject. Many of these subjects concern engineers, contractors and bonding companies, since they pertain directly to construction work, such as boilers, compressed air equipment, conveyors, cranes, derricks and hoists, dredges, engines, excavation, labor camps, labor laws, ladders, power-transmission apparatus, pressure piping, quarries, scaffolds and stagings, silicosis, stairways, steam shovels, tunnels, ventilation, and workmen's compensation laws.

Publications Received

THE ST. LAWRENCE SEAWAY is defended in a paper entitled Agricultural Traffic and the St. Lawrence Seaway, published by the Great Lakes-St. Lawrence Tidewater Association, Munsey Building, Washington, D. C. The subject matter of the paper is a reply by Hugh J. Hughes to statements made by Edwin G. Nourse in H. G. Moulton's book The St. Lawrence Navigation and Power Project in a section on agricultural traffic.

AMERICAN AIRPORT DESIGNS is a 96-p. publication with 73 full-page plates, contains 44 of the designs submitted in the Lehigh airports competition. The introduction is written by Clarence M. Young, Assistant Secretary of Commerce for Aeronautics. A feature of the publication is a seven-page account by Archibald Black, president, Black & Bigelow, Inc., air transport engineers, analyzing the various designs. This analysis is made "for the benefit of the serious student who desires to analyze these conceptions with a view to making practical use of their most valuable features." The publication of these designs and their analysis should prove interesting and useful to those engineers who are concerned with air transportation. ($3 from Taylor, Rogers & Bliss, 40 East 49th St., New York City.)

THE CLOSING CHAPTERS of the history of a famous canal are given in the final report of the consulting and directing engineer of the Morris Canal & Banking Co. to the State of New Jersey. The report is written by Cornelius C. Vermuele, Jr. Abandonment of the canal was authorized in 1924, just 100 years after the canal company was chartered by the state. Since abandonment was authorized the work of reconstructing or repairing the reservoir dams which are to be maintained, of removing canal structures, replacing bridges and culverts over and under the old canal bed has been in progress. That work is now complete. A major portion of the report is given over to an historical outline of the Morris Canal. (Morris Canal and Banking Co., State House Annex, Trenton, N. J.)

SUBURBAN TRANSIT for the Metropolitan District of New York is reviewed in a progress report prepared by the Suburban Transit Engineering Board. The board was organized two or three years ago by the Port of New York Authority to co-ordinate the activities of the various regional groups studying transit facilities throughout the metropolitan district. Its report is given over chiefly to the presentation of data collected for use as the basis of a comprehensive study of present methods and future suburban transit requirements. In one instance the report goes further toward the preparation of a definite suburban transit plan. The board has adopted as a basis for further consideration a plan for an independent loop system extending from points in New Jersey through Manhattan Island to Jamaica on Long Island. (Suburban Transit Engineering Board, 75 West St., New York.)

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

APPLIED MECHANICS—By Alfred P. Poorman, A.B., C.E., Professor of Applied Mechanics, Purdue University. Third Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x8¾ in.; pp. 306; figures in text. $2.75.

Aside from some rearrangement of material, many of the problems of the second edition have been replaced by new ones and "some additional examples have been used to clarify principles with which the author's students appeared to have difficulty." The first edition was noticed in these columns July 19, 1917, p. 131.

COMMERCIAL IRRIGATION COMPANIES—By Wells A. Hutchins, Irrigation Economist, Division of Agricultural Engineering, Bureau of Public Roads. Technical Bulletin No. 177, U. S. Dept. of Agriculture. Paper; 6x9 in.; pp. 40. 10c. from the Superintendent of Documents, Washington, D. C.

Interesting and suggestive facts and generalizations based on a study of 40 irrigation companies in the United States show that these concerns are giving way to "non-profit" community enterprises and tells the reason why.

THE DETERIORATION OF STRUCTURES IN SEA-WATER. Tenth (Interim) Report of the Committee of the Institution of Civil Engineers [under the auspices of the British] Department of Scientific and Industrial Research. Paper; 6x8½ in., pp. 44; line cuts and tables. 2s. from H. M. Stationery Office, London, or the British Library of Information, 5 East 45th St., New York City.

Deals with tests on timber, metal and concrete exposed to sea water.

EAST OF THE SPANISH MAIN—By George A. Johnson, 150 Nassau St., New York City. Reprinted from The Log of the Circumnavigators Club. Paper; 6½x10 in.; pp. 24; frontispiece and tables.

An interesting essay on the history, romance, natural resources, industry, trade, government and other topics relating to the West Indies, written by an American engineer.

THE EMPIRE MUNICIPAL DIRECTORY AND YEAR BOOK 1930-1931. 48th Annual Issue. London: The Sanitary Publishing Co., Ltd. Cloth; 7x9½ in.; pp. 332. 12½ sh.

As usual, this annual combines a directory of municipal officials in Great Britain, Ireland and the British Overseas Dominions with text and tables relating to municipal works and services—as roads, water supply, sewerage, fire prevention and motor vehicles in municipal service. Information on engineering societies is given and there is a directory of manufacturers.

PHILADELPHIA HOSPITAL AND HEALTH SURVEY, 1929—Conducted Under the Auspices of a Citizens' Survey Committee by Haven Emerson, M.D., Director of Survey; Sol Pincus, C.E., Associate for Health Studies; Anna C. Phillips, Associate for Hospital Studies. Philadelphia: Hospital and Health Survey Committee, Chamber of Commerce Building. Paper; 6x9 in.; pp. 844; illustrations and tables.

Included in this detailed survey are nearly 30 pages on food, milk, water supply, sewage disposal, housing and laboratory service. Water supply and sewage disposal are unfavorably criticised.

PRINCIPLES OF REAL ESTATE PRACTICE—By Roger D. Washburn, B.B.A., Director of the course in Real Estate Methods, the College of Business Administration, Boston University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 625; illustrations. $5.

A REPORT OF THE PROBLEM OF FIRE WASTE AND INSURANCE RATES IN THE CITY OF BOSTON—Prepared by the Mayor's Committee on Fire Insurance Rates, Felix Vorenberg, Chairman. Boston: City Messenger. Cloth; 8½x11 in.; pp. 319; halftones and line cuts. $4.50.

Said to be the first comprehensive study of the kind ever made for an American city. Among other things takes up "what there is to burn in Boston," building laws, the fire record, the fire department both in Boston and vicinity, and the water supply—the latter only 2 pp., showing what has and has not been done to carry out the 1925 recommendations of the National Board of Fire Underwriters. Should be of value to engineers and city officials concerned with fire losses and protection throughout the country.

THE SOCIAL PHILOSOPHY OF PENSIONS, with a Review of Existing Pension Systems for Professional Groups—By Henry S. Pritchett, President of the Carnegie Foundation. New York: The Carnegie Foundation for the Advancement of Teaching. Paper; 6x9 in.; pp. 85; tables.

SOVIET ECONOMIC DEVELOPMENT and American Business: Results of the First Year Under the Five-Year Plan and Further Perspectives—By Saul G. Bron, Former Chairman, Board of Directors, Amtorg Trading Corporation. New York: Horace Liveright. Cloth; 5x7½ in.; pp. 147; maps and tables. $1.50.

Comprehensive summary, designed particularly to encourage American dealings with Russia. May be read profitably, either alone or as supplementay to The Soviet Union Looks Ahead: The Five-Year Plan for Economic Construction, reviewed in this section Oct. 17, 1929, p. 624.

A STUDY OF THE IKEDA Short-Time (Electrical Resistance) Test for Fatigue Strength of Metals—By Herbert F. Moore, Research Professor of Engineering Materials, and Seichi Konzo, Research Graduate Assistant in Mechanical Engineering. Engineering Experiment Station Bulletin No. 205. Urbana: University of Illinois. Paper; 6x9 in.; pp. 34; illustrations and tables. 20c.

STANDARDS YEARBOOK: 1930—Compiled by The National Bureau of Standards; George K. Burgess, director. Cloth; 6x9 in.; pp. 301; tables. 75c. from Superintendent of Documents, Washington, D. C.

TENSILE PROPERTIES OF RAIL AND SOME OTHER STEELS AT ELEVATED TEMPERATURES—By John R. Freeman, Jr., Senior Metallurgist, G. Willard Quick, Associate Metallurgist, Bureau of Standards. Research Paper 164, Reprint from Bureau of Standards Journal of Research Vol. 4, April, 1930. Paper; 6x9 in.; pp. 42; line cuts, halftones and tables. 20c. from the Superintendent of Documents, Washington, D. C.

Besides describing tests and their specific results, "a theory is presented showing that internal failures, such as 'shatter cracks' and 'hair cracks,' may be due to thermal stresses developed in a steel structure while cooling through the secondary brittle range."

TREATED LUMBER, ITS USES AND ECONOMIES: Report of the Subcommittee on Retail Distribution of Treated Lumber of the National Committee on Wood Utilization. Fifteenth report of a series on the marketing and use of lumber. Washington: U. S. Government Printing Office. Paper; 6x9 in.; pp. 42; line cuts, halftones and tables. 15c. from the Superintendent of Documents, Washington, D. C.

Letters to the Editor

Curling Stresses in Concrete Pavement

Sir—There is a strong possibility that an important piece of research work bearing on the effect of curling (temperature) stresses in concrete pavement may be missed by many engineers, and I would therefore like to call it to the attention of your readers. I refer to a study made by Prof. H. M. Westergaard, published in the *Proceedings* of the sixth annual meeting of the Highway Research Board, p. 201, which contains the following formula for determining the tensile strength due to curling:

$$S = \frac{Ect}{2(1-p)}$$

Where S is the tensile stress produced, E is the modulus of elasticity of the concrete, c is the coefficient of expansion of the concrete per degree Fahrenheit, t is the difference in temperature between the top and the bottom of the slab in degrees Fahrenheit and p is Poisson's ratio for concrete.

Where this formula has been used in designing (and in many cases it is entirely ignored), the characteristics of the concrete are taken from data that has been obtained by testing concrete that is from 7 to 28 days old. This has led to fallacious conclusions as to the influence of curling upon the stresses in the concrete slab. It is my opinion:

1. Stresses due to curling are much higher than is generally assumed.

2. If the Westergaard formula is correct, stresses due to curling are directly proportional to the modulus of elasticity and the coefficient of expansion.

3. There is a wide variation in the values of modulus of elasticity and coefficient of expansion as among various concretes. According to our present knowledge, it would seem that the value of modulus of elasticity varies as the concrete ages and with the character of the aggregate used, and it is therefore impossible for the engineer to know the performance of the concrete slab as it ages.

4. If the Westergaard formula is correct, a concrete having the average characteristics of that material is sure to crack unless the slab is divided into sections as small as 10x10 ft. Since at the time of construction the engineer does not know whether his concrete has an average, a high or a low modulus of elasticity, he does not know how large each section of the slab can be made with safety.

Therefore, since stresses due to curling have such a great effect upon the formation of cracks in the concrete slab and since each individual concrete has its own particular values of modulus of elasticity, coefficient of expansion and modulus of rupture, does it not seem logical that each concrete pavement should be designed for the particular characteristics of the concrete that is to be used? Further, since time seems to have a material effect upon the properties of concrete, would it not seem necessary to know these values at ages greater than 28 days?

Roy M. Green,
President, Western Laboratories.
Lincoln, Neb.,
April 28, 1930.

A complete manuscript, giving the author's proofs for these conclusions was submitted, but space limitations forbid its inclusion.—Editor.

Flame-Cut Beam-to-Column Connections

Sir—In reference to the editorial "Steel Embrittlement by Heating," (*Engineering News-Record*, April 24, p. 674), we cannot concur in your statement that "all the intricacies and uncertainties which becloud the subject of brittleness in steel are brought to the fore by the studies made in the Columbia University laboratories of a number of cracked and broken windbrace connections." The conclusions reached by Professor Krefeld are in substantial agreement with those reached in about 40 other investigations. The only tests which to our knowledge are in conflict with the conclusions reached by previous investigators are those reported by J. H. Edwards in your issue of Nov. 1, 1928, p. 666.

The statement that Professor Krefeld's report does not show that flame-cutting after punching causes grain growth is of significance, as it indicates that the editor does not understand the embrittlement phenomenon resulting from low-temperature annealing. Grain growth cannot take place at the temperatures produced and has never been found to exist in any of the 40 investigations, referred to above, where the annealing temperature is less than 550 deg. C.

Any variations in the conclusions reached by previous investigators are quantitative and not qualitative. The quantitative differences have been carefully studied by us and are primarily due to slight differences in the chemical composition of the steels investigated.

The question at issue is not whether ordinary soft structural steel is embrittled by "intense local heating which accompanies oxygen-torch cutting or welding of steel, when done after cold-working," for that this is the case has been definitely established by all previous investigators except Edwards. The question at issue is, "Shall the engineering profession squarely face the facts and attempt to develop a steel which can withstand safely the punishment it is subjected to in modern fabrication processes or so to modify these processes that embrittlement cannot be a serious factor"?

Both the article as abstracted and the editorial seem to indicate that there is a dearth of scientific knowledge on the problem of embrittlement resulting from heating previously overstrained steel, and this is not the fact. Professor Krefeld's work should be interpreted in the light of all available data and not solely in the light of a few crude tests performed on very low-strength so-called structural steel.

The editor's criticism that Professor Krefeld has not investigated the desirability of using a more ductile low-strength steel in preference to a strong and hard steel when flame-cutting must be done has no application to the data reported. The steel that was investigated was a typical ductile structural steel with an ultimate tensile strength of 59,350 lb. per square inch and an elongation in 2 in. of 37.25 per cent. Such a steel cannot be classed as a strong, hard steel. On the other hand, an article on "Flame Cutting of Structural Steel" by S. W. Miller and J. R. Dawson (*Engineering News-Record*, May 9, 1929, p. 760) reports an investigation of steel taken from a 24-in. I-beam which had a tensile strength of only 50,700 lb. per square inch and a yield point of 28,000 lb. per square inch. This steel cannot be classed as a structural steel under any standard specification.

It would appear that, instead of attempting to evade the issue, the proper plan would be for those interested to face the facts squarely and to carry on an extensive investigation with a view to developing a structural steel which can safely stand the desired fabricating processes, and also to investigate modifications necessary in fabrication and erection processes so that the steel available at present can be used with safety.

Preliminary investigations made by us indicate that slight changes in the chemical composition of structural steel have enormous influence upon its resistance to embrittlement. Very recently we investigated a special steel of structural grade which under the worst possible treatment of cold-working, followed by low-temperature heating, still has a residual shock resistance greater than the normal structural steel available today under its best conditions.

Albin H. Beyer,
Professor of Civil Engineering
and Director of Testing,
Columbia University
New York City,
April 28, 1930.

What Professor Beyer brings out is not directly pertinent to our brief editorial discussion. Our criticism of the bulletin in question was based on its own inadequacy and disappointing character, not on its agreement or disagreement with the views of others. It set out to answer a question on the cause of certain breakages, and failed to answer the question. It devoted a large amount of space to matters not connected in any recognizable way with the circumstances of the breakages. It expressed "conclusions" wholly unsupported by its own data and in conflict with some of them. It presented conflicting experimental results and did not attempt to harmonize them. In short, it took up for discussion an important current question and dealt with it ineffectively and misleadingly. We believe that if a college laboratory after large expenditure of money and time publishes such results, the publication is unfortunate and tends to confuse rather than to assist the advance of the practical art.—Editor.

News of the Week

C. K. Dykstra Appointed City Manager of Cincinnati

The appointment of Clarence K. Dykstra, professor of government at the University of California, Southern Branch, and director of personnel and efficiency for the Los Angeles Department of Water and Power, to the post of city manager of Cincinnati, Ohio, was announced early this week. He succeeds Col. C. O. Sherrill, who resigned the $25,000 position to become vice-president of a chain grocery firm (*Engineering News-Record*, May 1, p. 738).

Selection of Prof. Dykstra was preceded by an announcement by Lieut.-Col. U. S. Grant, 3d, director of public buildings and public parks of the District of Columbia, that he had refused the appointment as city manager at Cincinnati. Colonel Grant explained that he prefers to remain in Washington, where he is interested in a number of projects of great importance now under way.

Last Link of N. Y.'s Triborough Bridge Approved

The War Department has approved plans for the fourth span of the so-called triborough bridge in New York City. This span will be built across the Harlem River, connecting 125th St., Manhattan, and Randalls Island. Plans for the bridge were revised after a public hearing in which objections were offered by the New York, New Haven & Hartford Railroad, the Pennsylvania Railroad and the New York Towboat Exchange. The present plans call for a lift bridge in place of the bascule bridge, increasing the vertical clearance from 50 to 55 ft. at mean high water and providing a horizontal clearance of 250 ft. between the abutment of the channel stand and 204 ft. at right angles to the channel.

This bridge is one of four planned by the city in its triborough bridge system which will link Manhattan, Queens and the Bronx. The War Department has approved the three others, and work has been started on the Queens site at Jamaica. The entire system will cost about $30,000,000.

Phoenix, Ariz., to Vote on Water and Sewer Bonds

The city commission of Phoenix, Ariz., on May 7 took the initial step toward submitting to the citizens of Phoenix a bond issue for $3,758,238.31 to provide the city with badly needed additional water and sewer facilities. The commissioners instructed City Attorney Carson to prepare an ordinance calling for a bond election.

Arizona Organizes to Fight Boulder Dam

Arizona is prepared to employ every legal means possible to prevent Congress from making the initial appropriation asked by Secretary of the Interior Wilbur for construction of the Boulder Canyon dam. John Mason Ross and A. H. Favour, members of the Arizona Colorado River Commission, will join Arizona's congressional delegation in Washington Saturday, May 17, to aid in an attempt to prevent the passing of the appropriation. C. C. Cragin, chief engineer of the Arizona Salt River Valley Water Users' Association and an expert in hydro-electric contracts, is to join the Arizona group in Washington Sunday, May 18, arriving in time for the hearings on Monday before the House committee on the proposed appropriation. Should the appropriation pass, K. Perry Peterson, attorney-general of Arizona, is prepared to file suit in the U. S. Supreme Court attacking the constitutionality of the Swing-Johnson bill.

Thirteen Grade Crossings to Be Eliminated in Albany

Orders for the elimination of thirteen grade crossings in Albany have been issued by the Public Service Commission of New York. Cost of the elimination is estimated at $3,000,000, of which the Delaware & Hudson Railroad will pay half, the state 49 per cent, and Albany County 1 per cent.

These orders clear the way for the construction of a bridge between Albany and Rensselaer, for which all approvals have been obtained.

Borings for San Francisco Bridge Show Rock at Great Depths

A preliminary report by State Engineer C. H. Purcell of California on the result of test borings for piers for the proposed San Francisco-Alameda County bridge over San Francisco Bay indicates great variation in the depths to bedrock in the suggested sites for the bridge. For the Sixteenth St. line, rock was found at only one boring, 292 ft. below mean low water; for the pier 34 line, bedrock was found at depths of from 44 to 293 ft., but many borings were stopped at 300 ft. when rock was not found at that depth; for the Goat Island line, bedrock was struck at depths varying from 87 to 323 ft. It is expected that the borings will be completed by July 1.

Virginian Railway to Connect With N. Y. Central

The Virginian Railway has been authorized by the Interstate Commerce Commission to establish a connection with the New York Central system by bridging the Kanawha River at Deepwater, W. Va. The Virginian is allocated to the New York Central in the commission's consolidation plan, and in its report approving the bridge project the commission stated that in pursuance of this plan the properties should be united by a direct physical connection. Location of the bridge has been agreed upon with the War Department, and the cost is estimated at $1,000,000. This connection will free the New York Central and the Virginian from all dependence upon the Chesapeake & Ohio in moving freight between Middle West and Lake territory tributary to N.Y.C. lines and Southeastern territory served by the Virginian and its connections. The project was vigorously opposed by the C. & O. on the ground that the new route would be less efficient and less economical than its own line to the west and would develop no new traffic. The New River, Winding Gulf, and Kanawha coal operators indorsed the project because it will open another tidewater port, Norfolk, which would be advantageous at times of congestion at Newport News and would provide a two-line route to Lake Erie from mines served by the Virginian.

War Department Reopens Hearing on Hudson River Bridge

A new hearing on the construction of a combined railroad and vehicular bridge across the Hudson River at 57th St., permission for which has several times been refused by the War Department, will be held on June 4 in New York City before a special board of officers headed by Col. G. M. Hoffman, of the Corps of Engineers. Recently Secretary of War Hurley, in company with Major-Gen. Lytle Brown, Chief of Engineers, inspected the proposed site and it is believed that the matter has been reopened as a result of this inspection.

The application was made by the North River Bridge Co., of Jersey City, N. J., and figures made public by Colonel Hoffman disclose that the bridge company has effected a slight change in its plans, to allow for 9 ft. more clearance above high water level in the river than in its maximum plans disapproved last year. Three alternate clearances are now under consideration, the highest one 184.8 ft. for a width of 300 ft. at the center of the span, and the lowest 175.8 ft. for the same width. Otherwise the plans for the structure remain essen-

tially the same, with provisions for two decks, the lower to accommodate twelve railroad tracks and the upper one twenty lanes of vehicular traffic, with sidewalks for pedestrians. The bridge would be of the suspension type, with a central span of approximately 3,240 ft. and two side spans of 1,590 ft. each.

After an exhaustive study by army engineers, the project was disapproved last May by the late James W. Good, Secretary of War, and Major-Gen. Edgar Jadwin, Chief of Engineers, as a menace to navigation, with the intimation that a plan providing greater clearance might be accepted.

Appointments by Reorganized Port of New York Authority

The Port of New York Authority, recently reorganized by the legislatures of the states of New York and New Jersey, which has under its jurisdiction operation of the Holland tunnel, the Outerbridge Crossing, the Goethals bridge and the Kill van Kull bridge, the construction of the Fort Lee Hudson River bridge, and the building of the New York-Weehawken tunnel when this shall be authorized, has announced appointments as follows:

General manager, John E. Ramsey; chief engineer, O. H. Ammann; assistant general managers, Billings Wilson and John J. Mulcahy; superintendent of tunnel operation, E. Morgan Barradale; general superintendent of bridges, Sydney Cumberledge. Glenn S. Reeves is continued as transit engineer of the Port Authority. Appointments to the general engineering staff include the following: assistant chief engineer, E. W. Stearns; engineer of terminals, J. C. Evans; engineer of construction, M. B. Case; engineer of design, Allston Dana; engineer of research and tests, R. S. Johnston; engineer of steel inspection, H. J. Baker; engineer of masonry inspection, A. W. Munsell.

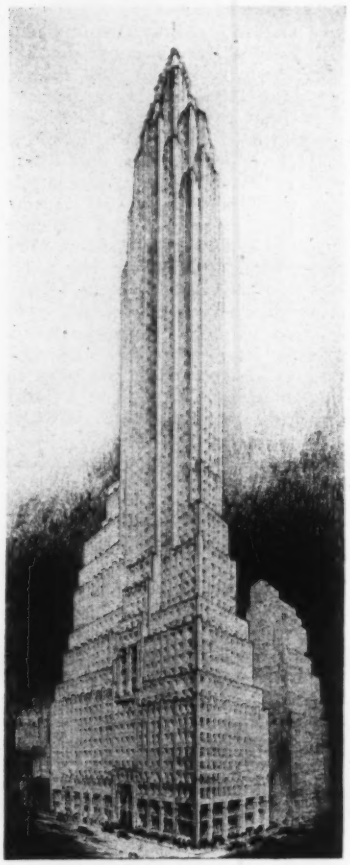
Ole Singstad, who became chief engineer of construction on the Holland tunnel following the deaths of Clifford M. Holland and Milton H. Freeman, will be chief consulting engineer on tunnels, including the proposed vehicular tunnel between New York and Weehawken. A fund for making of borings and studies on the latter project has been authorized in a resolution adopted by the board.

Causeway and Tunnel Approved for Tampa, Fla.

The War Department has approved the plans of the Tampa Subway Corp., Tampa, Fla., for a combined causeway and tunnel to be constructed over and under Hillsboro Bay 9.7 miles from Tampa, under authority of state law. The plan includes building a 110-ft. bascule span with 20 ft. clear height above mean low water, as well as the construction of a tube the top of which will be at least 45 ft. below mean low water for a distance of 800 ft. at the main channel.

New York Law Regulating Grade-Crossing Work Amended

Governor Roosevelt of New York has signed the bill amending the labor law regulating the hours of work and the wages of laborers, workmen and mechanics on railroad grade-crossing eliminations, by declaring that the hours of labor shall be the same as on other public work and that workmen shall be paid at the prevailing rate of wage. It is expected the railroad companies will attack the constitutionality of this law in the courts.



SKYSCRAPER TO HAVE DOUBLE-DECK ELEVATORS

Plans have been filed by interests affiliated with Henry L. Doherty & Co. for a 63-story skyscraper, to be erected in the Wall St. district of New York City at a total cost for land and building of $15,000,000. For the first time in building design it is planned to use double-deck elevators which will load and unload at two floors simultaneously. It is reported that this structure is the first of a series of tall buildings to be erected by the Doherty interests in downtown New York. The architects are Clinton & Russell and Holton & George. James Stewart & Co. will be the builders.

Construction Started on Railway in Saskatchewan

Construction has been started on the railway line which the Canadian Pacific is building across northwestern Saskatchewan from Prince Albert. This line, when completed, will also traverse a portion of northern Alberta, terminating at Lac la Biche, on the Alberta and Great Waterways line of the Northern Alberta Railways. Before the branch line is brought to completion upward of 300 miles of construction will be involved. The work at present undertaken is a portion, 90 miles in length, between Debden, a point on the Canadian National Lines northwest of Prince Albert, and Meadow Lake. The present construction is proceeding toward Prince Albert from the new bridge at Nipawin over the Saskatchewan River, 75 miles east of Prince Albert.

N. Y. Sewage Works Association Holds Annual Meeting

The second regular annual meeting of the New York State Sewage Works Association was held in Albany on May 10. In the absence of President Kenneth Allen, Vice-President C. A. Holmquist presided. Sixty-one members and guests were present.

The morning session was devoted to the regular business of the association and to the presentation and discussion of two papers, one on "Operating Experience at the Syracuse Treatment Works," by W. P. Gyatt, chief operating engineer, and the other on "Essentials of Operation and Control of Small Sewage-Treatment Plants," by C. C. Agar, of the state department of health.

Wellington Donaldson (New York City), W. A. Ryan (Rochester) and C. L. Walker (Ithaca) were elected members of the executive committee for three years to succeed the retiring members, R. Suter, R. H. Gould and Kenneth Allen. Mr. Allen, however, will continue to serve on the committee for another year as an advisory member. The officers for the ensuing year are: C. A. Holmquist, president; Morris M. Cohn, vice-president, and A. S. Bedell, secretary-treasurer.

The report of the committee on the short school for sewage-works operators was received with interest, as plans are being formulated for holding a one-week school at Schenectady next fall. A lively round-table discussion on the effect of industrial wastes on the operation of municipal sewage-treatment plants, the propriety of allowing cellar drains to be connected to the sewer system and the specifications for house connections was led by R. S. Lanphear, R. C. Wheeler and Fred Fisch.

The meeting closed with an inspection trip to the Albany sewage-treatment plant and to the treatment works serving the Albany County buildings, where very complete treatment and odor control were well exemplified.

The next meeting of the association will be held on Sept. 6 in Syracuse.

Engineers Head Newly Formed Construction Organization

E. A. Yates, formerly vice-president and general manager of the Alabama Power Co., Birmingham, Ala., has been appointed executive head of the Allied Engineers, Inc., the organization set up by the Commonwealth & Southern Corp. to handle its engineering and construction work. O. G. Thurlow, chief engineer of the Alabama Power Co., has been appointed vice-president of the new company and will be in charge of its activities in the South, with headquarters in Birmingham. A. C. Polk, president of the Dixie Construction Co., has also been appointed a vice-president of the new company. Mr. Yates and Mr. Polk will make their headquarters in New York.

The new company recently acquired by consolidation or purchase the engineering and construction business formerly conducted by Stevens & Wood, the Dixie Construction Co. and the Empire Construction Co. It will carry on the present activities of the constituent organizations and will also perform engineering and construction work throughout the country.

Mr. Yates has been associated with the Alabama Power Co. since its organization in 1912, when he became chief engineer. In 1923 he was elected vice-president and general manager; subsequently he was made a director of the company as well as vice-president and a director of the Southeastern Power & Light Co.

Mr. Thurlow also entered the service of the company in 1912 as its designing engineer. In 1914 he succeeded Mr. Yates as chief engineer. In 1926 he was made a vice-president and director of the company and his duties were extended to include construction and engineering activities in a number of the affiliated companies. His achievements in the design of power dams include the Thurlow backwater suppressor first built into the Mitchell dam on the Coosa River.

Mr. Polk is another of the engineers who came to the company on its organization in 1912, becoming resident engineer on the construction of the dam at Lock 12 on the Coosa River. In 1923 he was appointed construction manager and has since been in direct charge of all construction activities of the company as president of the Dixie Construction Co.

The Commonwealth & Southern Corp. holds large interests in the Southeastern Power & Light Co. and through it in the Alabama Power Co.

Court Holds Up Power Project in Centralia, Wash.

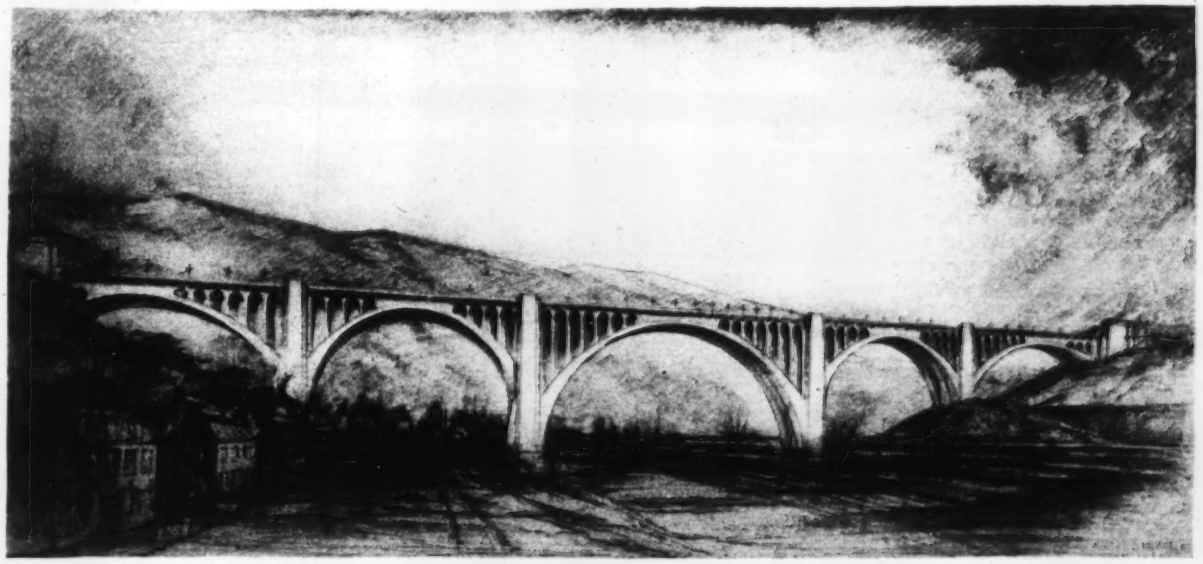
The Centralia (Wash.) city commission has been ordered by the Supreme Court to stay any proposed plans to issue $650,000 utility bonds for the completion of a municipal $1,000,000 hydro-electric power project pending hearing on an appeal scheduled for May 15. The appeal is on a dismissal in a lower court of an injunction suit. The order follows closely the award of a contract to the Puget Sound Bridge & Dredging Co., Seattle, Wash., for $477,538, to complete the project.

Committee Appointed to Readjust Baltimore Water Rates

Charles F. Goob, chief engineer of Baltimore, has appointed a committee to consider water rates for the Metropolitan District of Baltimore County, with the view of bringing about a readjustment. The members are Ezra B. Whitman, former water engineer and former chief engineer of Baltimore and also formerly chairman of the Maryland Public Service Commission; Abel Wolman, chief engineer of the Maryland State Health Department, and Bernard L. Crozier, chief engineer of the Metropolitan Commission and a former chief engineer of Baltimore.

Large Drydock Plant for New York State Barge Canal

Work will be begun soon at Newark, N. Y., on the largest drydock on the New York State Barge Canal system, according to E. C. Keeler, division superintendent of the canal. The dock will be 600 ft. long by 160 ft. wide. When filled, the extreme depth will be 16 ft., with a depth of 12 ft. in the clear over the "chairs" on which the boats rest when the water is withdrawn. The dock will take the largest boats that can go through the canal. Its extreme capacity will be a 300-ft. boat with a 44-ft. beam and a draft of 12 ft. The gates will be of steel and will be operated by the power at Lock 28-A. Shops will be built at the dock fitted with electric welders and other mechanical equipment required for the building or repairing of floating equipment.



GEORGE WESTINGHOUSE BRIDGE AT PITTSBURGH, PA.

The center arch of the new George Westinghouse bridge in Pittsburgh, Pa., will be the longest concrete arch span in the United States when completed. It is 460 ft. center to center of abutments, with a clear span of 420 ft. Contract for the construction of the bridge was recently let by the Allegheny County Department of Public Works to Booth & Flinn, of Pittsburgh, at a bid price of $1,482,754. The bridge is located between East McKeesport and the city of Pittsburgh, and provides a crossing for the Lincoln highway over Turtle St. and the freight yards of the Pennsylvania Railroad. Norman F. Brown, director of public works, and V. R. Coval, chief engineer, bureau of bridges, will supervise the construction for Allegheny County.

World Power Conference Committee to Move to New York

Headquarters of the American committee of the World Power Conference will be moved from Washington to New York on July 1. A year's experience with the offices of the committee in Washington has demonstrated that greater efficiency can be secured by having headquarters in New York, where the committee will be more accessible to those having dealings with it.

Reports to O. C. Merrill, chairman of the committee, indicate that attendance at the Berlin conference will exceed 4,000, whereas only 1,700 delegates attended the 1924 conference at London. The American delegation will sail from New York on June 4.

Plan Proposed for Irrigation of Rio Grande Valley

Active steps have been taken by W. E. Anderson, of San Benito, member of the International Water Boundary Commission, and representatives of large American irrigation interests of the lower Rio Grande Valley to file applications with the State Board of Water Engineers for rights to dam sites on the international boundary stream. These rights will have to be ratified by the United States and Mexican governments. The construction of the proposed dams is to conserve the water supply of the Rio Grande for its prorated use on both sides of the river.

It is estimated that 1,000,000 acres on each side of the Rio Grande are subject to irrigation. This would mean a 2,000,000-acre irrigation project on the river if the dams are built. The annual flow is about 5,000,000 acre-ft. The International Water Boundary Commission has for several years been attempting to reach an agreement on the use of waters of the river, but so far has not been able to do so. Immediate action is being urged by irrigation districts of the lower Rio Grande Valley in view of large irrigation developments on the river. Most of these developments, however, are required to have local storage so that they will not have to take the water when the river is low.

Three general dam sites are considered. That is, there are two widely separated sites, and three grouped together, from which one will be selected. The first is at Salineno, known as the "Island of the Last Rock." It is about 14 miles west of Roma and about 100 miles from San Benito. The annual flow of the Rio Grande at this point is now about 4,200,000 acre-ft., or enough to irrigate all irrigable lands on both sides of the river between that point and the mouth of the river. It is estimated that a 70-ft. dam would impound 400,000 acre-ft. of water. This would be mainly a regulatory dam. The fall of water, 70 ft., would be sufficient to furnish power for all valley irrigation.

The second site is at El Jardin, half way between Eagle Pass and Laredo. A dam 110 ft. high, impounding approximately 1,000,000 acre-ft. of water, is contemplated. The annual flow is about 3,600,000 acre-ft. This dam would be an important cog in the conservation program and in the regulatory work also.

Either or both of these structures would solve the valley's water problems for years, but larger dams, in the Big Bend section, are contemplated for ultimate solution. Three dam sites are being considered in the Big Bend, at Mariscal, Boquillas and Santa Helena. A 200-ft. dam could be constructed to impound 2,000,000 acre-ft. of water at any of these points.

The Business Outlook

The business situation is discouragingly static. *The Business Week's* preliminary index of general business activity stands at 94 per cent normal, unchanged from the revised index for the preceding week. Steel mill activity showed a further slight decline, falling from nearly 78 per cent to slightly below 77. In the long-range view, business is now suffering chiefly from a pain in the expectations. It is hard to reconcile ourselves to a level of business that can be maintained without economic miracles or political pulmotors.

—The Business Week, May 14.

New Power Line From El Paso to Las Cruces

Construction of a 66-kv. transmission line from El Paso, Tex., to Las Cruces, N. M., has been authorized, and work will begin as soon as materials have been received. This new line, which will supply power to the Mesilla Valley Electric Co. and the upper Rio Grande Valley, will be approximately 39 miles in length. It is to be fed from the Rio Grande power plant of the El Paso Electric Co., recently built at a cost approximating $5,000,000. About $340,000 will be expended upon this construction. This includes substation buildings and all equipment. The plans include a large substation and other equipment at Las Cruces.

New Bridge Planned for Frazer River in Canada

The board of directors of the Pacific Great Eastern Railway has voted to call for bids for the diversion of its line into the town of Lillooet and the erection of a new bridge over the Fraser River, at an estimated cost of approximately $500,000. Five miles of new line are involved in this change of location.

Prizes Awarded to Students for Bridge Designs

Supplementing the bridge design competition recently held among architectural students, the American Institute of Steel Construction has awarded three cash prizes and one honorable mention to four engineering students for esthetic designs of a steel arch bridge. The first prize of $500 was awarded to John Heckathorn, of the University of Idaho; the second prize of $250 went to J. Hoogstraten, of the University of Manitoba, and the third prize of $100 was awarded to William Niessen, of Drexel Institute. Honorable mention was given to J. B. Striowski, of the University of Manitoba.

The judges were Gustav Lindenthal, of Jersey City; J. E. Greiner, of Baltimore, and O. H. Ammann, of New York, consulting engineers; and Theodore E. Blake, of New York, and Stephen F. Voorhees, of New York, architects. The problem called for the design of a steel bridge of 650-ft. total length and with a main arch span of 325 ft., to be erected over a river separating a suburban residential section from an industrial city.

Progress on Diablo Power Project

The Diablo dam, built to impound water to operate the new hydro-electric power plant which the city of Seattle, Wash., is constructing on the Skagit River at Diablo, is expected to be completed next September, Winston Bros., contractors, have announced. Completion of the dam will absorb virtually one-half of an appropriation of $13,500,000 recently approved by the city council to finance a five-year development program for the city lighting department. It will enable the city to operate to capacity its present Gorge Creek power plant while waiting for the new Diablo plant.

Two electric generators for the new Diablo power house, and the water turbines to operate them, rated at 85,000 hp. each, were ordered recently for delivery early next year. These will double the city's present production of electricity. Bids for construction of the power house will be called for soon. With its equipment, the power house is estimated to cost between $3,000,000 and $3,250,000. The power tunnel, through which water will be brought to this plant from back of Diablo dam, soon will be finished at a cost of about $750,000 under a separate contract by Rumsey & Jordan. Construction has already been started also on a complete new transmission line, to extend from Diablo into Seattle, at an estimated cost of $2,800,000.

Plans are being made to follow completion of the Diablo development with construction of a control dam at the junction of Ruby Creek and the Skagit River, about 6 miles above Diablo. This would form a reserve lake about 27 miles long.

Engineering Council Acts on Bills Before Congress

Opposition to the provision of the rivers and harbors bill providing for the acceptance by the government from the State of New York of the Erie and New York barge canals was expressed in a resolution adopted by the administrative board of the American Engineering Council at its meeting on May 12-13 in Washington. The board also adopted recommendations with respect to many other legislative proposals now pending in Congress. Establishment of engineering experiment stations at land-grant colleges by a system of federal aid to the states as proposed in the McNary-Haugen bill was indorsed. The board went on record against the Phipps resolution for the creation of a governmental commission to supervise plans for the establishment of a national system of express motorways. Appointment of a committee to study legislation for the establishment of air transport service in foreign commerce was authorized. A committee also will be appointed to suggest procedure whereby the government will bear the expense of moving the household effects of civilian engineers who are transferred from one post to another.

Brief News

CONSTRUCTION OF A HANGAR 120x440 ft. has been started on the 230-acre site of the San Francisco Bay airdrome near Alameda, Calif.

THE PROPOSAL by the Niagara Falls Parks Commission to construct a bridge across the Niagara River has been rejected by the Canadian Parliament.

A NEW CANADIAN NATIONAL RAILWAY STATION at London, Ont., will be started late in 1931. It will be one story in height with tunnel access to the elevated tracks and bridge exits. The building will cost at least $700,000.

ROAD SIGNS to the number of 100,000 will be placed on New York state highways this spring, it is announced. Both state and federal routes will be marked, and signs giving the names of cities the motorist is approaching also will be erected.

CANADIAN CONTRACTORS have been invited for the first time to bid on a large project on foreign soil against competitors from the United States. The project is a hotel at Castle Harbor, Bermuda, and three Canadian contractors have been invited to submit bids.

THE UNIVERSITY OF MONTANA will convert its forest school from a school of silviculture to one of wood technology, in recognition of the fact that the forestry problem requires emphasis on utilization more than on the side of forest perpetuation. A forest products laboratory will be provided to co-operate with the research work of the U. S. Forest Products Laboratory and of the National Lumber Manufacturers Association.

CO-OPERATIVE EXTENSION SPECIALISTS in agricultural engineering will hold their first national conference at Urbana, Ill. June 11 to 14. The program includes discussion of extension methods and plans for developing agricultural engineering as it relates to the farm water supply, farm machinery, control of soil erosion, and related subjects.

SANITARY SEWERS for the San Fernando Valley will be constructed in the near future at a cost of approximately $1,000,000 as the result of action by the Los Angeles Board of Public Works.

WASHINGTON NOTES

By PAUL WOOTON
Washington Correspondent

Effectiveness of Bonnet Carré Spillway Doubted—New Power Control Favored by Testimony

IN ADVOCATING before the flood-control committee of the House of Representatives a spillway below New Orleans, John Klorer, a New Orleans engineer, contended that the Bonnet Carré spillway could not be relied upon to maintain a gage of 20 ft. at New Orleans. "The relation between the gage heights and discharge on the Mississippi River," he told the committee, "is not the simple mathematical relation that some persons believe it to be. Discharges as measured at Carrollton or New Orleans show astonishing variations for the same gage reading, taking floods of separate years and free from crevass influence. Differences of as much as 130,000 sec.-ft. for the same gage reading have been recorded." To provide for the possibility that Bonnet Carré will not be sufficient he asked that the War Department be authorized to construct another spillway below the city should the army engineers deem it necessary. In this way, he urged, it will be possible to go ahead with that work without the delay incident to securing the necessary legislation, should the expectations for Bonnet Carré not materialize.

The flood-control committee also heard representatives from various backwater areas who are seeking an amendment to the flood-control act which will permit of levee construction at federal expense in such area. If the federal government will not protect the lands in the backwater areas the committee was told that the owners of lands overflowed as an incident to flood-control works should be paid for the use of their lands for storage purposes.

Other witnesses urged the federal government to assume the cost for the securing of rights-of-way for levees. It was pointed out that levees are being so relocated as to exclude many thousands of acres of cultivated land from their protection. It was estimated that damages aggregating $6,000,000 will have to be paid by the states for such lands. Since the relocation of the levees is in the interest of several states, it was contended that the money should come from the general treasury.

Chairman Reid, of the flood-control committee, announced that testimony would be taken from representatives of the Corps of Engineers before the committee was asked to pass upon any of the proposed amendments.

Railway Bus Connections

The Pennsylvania Railroad's proposal to inaugurate free bus transfer service at New York and Newark for parties of 25 or more was debated at a final hearing before the Interstate Commerce Commission on May 7. The expectation is that the commission will permit the Pennsylvania's tariff to become effective, as it had previously announced its decision not to bring into the investigation the bus service operated without tariff authority by the Baltimore & Ohio Railroad between its rail terminal at Jersey City and points on Manhattan Island. An order canceling the Pennsylvania's tariffs would oblige the commission to take action regarding the B. & O.'s practice, and as an alternative, it is believed that the commission will submit at the next session of Congress in December a recommendation for legislation placing motor vehicles used by the railroads for passenger terminal service in the same category as ferryboats.

Oil Pollution Deprecated

Hearings are being held by the House rivers and harbors committee on a bill introduced by Representative Hudson of Michigan for the purpose of amending the oil pollution act of 1924. It is proposed to extend the provisions of the act to include inland navigable waters. Dr. George W. Field, representing societies for the preservation of wild life, told the committee that great numbers of migratory birds as well as fish are destroyed annually by oil pollution in inland waters.

The consensus of opinion among those indorsing the bill is that the oil industry is doing all it can to co-operate. Some of the witnesses who testified pointed out that much of the pollution along coastal waters is caused by tankers dumping their ballast and waste before they come to the 3-mile limit under the jurisdiction of the United States. The opinion was expressed that international agreement would be necessary before complete control can be effected.

Electric Railway Fights I.C.C.

A petition filed by the Interstate Commerce Commission for an injunction restraining the Piedmont & Northern Railway from extending its lines without first obtaining a certificate of public convenience has brought a reply from the electric railway in which the commission's jurisdiction is challenged on the ground that the road is an interurban electric railway. The company

stated that it will continue construction unless the injunction sought by the commission at the hands of the U. S. District Court for the Western District of South Carolina is granted.

Construction work on the projected extensions from Spartanburg to Gastonia, S. C., and from Charlotte, N. C., to Winston-Salem, N. C., was started March 11 (*Engineering News-Record*, March 27, p. 537), after the company failed to obtain in the federal courts an injunction against the commission's order denying the application to construct the lines. In refusing to grant an injunction against a negative order, the U. S. Supreme Court also declined to render a decision on the question of the commission's jurisdiction, suggesting that the company should commence construction without a certificate, thus inviting a positive decision by the court on the interpretation to be given to section one (22) of the interstate commerce act, in which electric street, suburban and interurban railways are exempted from the commission's jurisdiction over construction and abandonment of line.

New Power Commission Favored

Advocacy by the administration of a Federal Power Commission to be independent of the three departments now responsible for the administering of matters pertaining to water resources came as a surprise on Capitol Hill. Secretary Wilbur, of the Interior Department, and Secretary Hyde, of the Department of Agriculture, members of the present commission, appeared personally before the interstate and foreign commerce committee of the House of Representatives, which is considering the Parker power bill. Their testimony left no doubt as to the attitude of the administration.

An explanation being offered by those who are opposed to the building up of an independent agency like the Interstate Commerce Commission is that the administration is anxious to be rid of direct responsibility in connection with a controverted subject. The position taken by the administration was unexpected, because President Hoover has been outspoken in his opposition to independent agencies, contending that such activities should be attached to departments so that the head of a department can keep in touch with what is going on and be responsible for the proper conduct of the work.

Opponents of the bill contend that this is the entering wedge looking to the valuation of all power plants and facilities after the manner of the valuation of the railroads. In that connection they point out that valuation of the railroads has been at a time when their growth was proceeding slowly. This comparatively easy task is expected to cost $155,000,000. To evaluate a rapidly expanding industry such as the generation and transmission of power is expected to cost much more. It also is believed that an independent commission ultimately would insist upon having an entire field force of its own. This is expected to lead to friction and duplication of effort.

Personal Notes

S. F. CRECELIUS has been appointed city engineer of El Paso, Tex. Other appointments include those of HAL G. STACY and W. E. STOCKWELL as assistant city engineers.

JOHN WELLINGTON FINCH, consulting engineer, of Denver, Colo., has been elected a member of the board of directors of the Denver Chamber of Commerce.

C. HARRY MONETT, of San Francisco, has been appointed water master over the Kern Island Canal Co. system in Kern County by the California Railroad Commission.

FRANK M. GUNBY, of Boston, Mass., has been appointed to represent the American Society of Civil Engineers on the administrative board of the American Engineering Council, taking the place caused by the death of Frank M. Williams, of Albany, N. Y.

WARREN VIESSMAN, engineer at the head of the bureau of mechanical-electrical service, Baltimore, Md., has been put in temporary charge of the municipal bureau of stores by Chief Engineer Charles F. Goob. He will serve until Mayor Broening makes a permanent appointment.

PIERRE M. GHENT, of Baltimore and Hagerstown, Md., has discontinued his services with the Western Maryland Railway Co. and is now employed as assistant engineer of design, grade 1, by the Westchester County Park Commission, with headquarters at Bronxville, N. Y.

ROBERT W. LEEP, for some years a member of the engineering staff of the Eastern Oregon Light & Power Co., Baker, has resigned to accept the position of county engineer of Baker County, Ore.

JAMES C. MCGUIRE, of New York City, was elected a life trustee of Rensselaer Polytechnic Institute, and ROYAL G. FINCH, of Albany, N. Y., was elected alumni trustee for three years from the Eastern district at the annual meeting of the institute board on May 7.

FRANK E. RICHARDSON, formerly assistant chief engineer of the Continental Oil Co., together with A. W. RUSH, has formed a construction and engineering company under the name of the Allied Construction & Engineering Co., with offices in Tulsa, Okla. They plan to major in oilfield construction in all its phases.

N. B. MCLEAN, who has been assistant chief engineer of the River St. Lawrence Ship Channel, Department of Marine, Ottawa, Ont., has been appointed chief engineer to fill the vacancy caused by the retirement of the former chief engineer, V. F. W. Forneret.

W. E. CAPWELL has tendered his resignation as city engineer of Chula Vista, Calif., but the council has offered him a two months' leave of absence and he has the offer under consideration. He has been city engineer since 1915.

Society Calendar

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; annual meeting, Atlantic City, N. J., June 23-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; annual convention, Cleveland, Ohio, July 9-11.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

INTERNATIONAL CONGRESS OF BUILDING AND PUBLIC WORKS, London; fifth congress, London, England, May 26-30.

NATIONAL SAFETY CONGRESS, Chicago; annual meeting, Pittsburgh, Pa., Sept. 29-Oct. 3.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, Pittsburgh, Pa.; 38th annual meeting, Montreal, Canada, June 26-28.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

AMERICAN INSTITUTE OF ARCHITECTS will hold its 63d annual convention in Washington, D. C., May 21-23. "Modernism" will be the theme of a symposium, in which the whole field of contemporary architecture will be discussed.

ENGINEERS CLUB OF ST. LOUIS, MO., held its annual election of officers on May 8. W. O. Pennell, chief engineer of the Southwestern Bell Telephone Co., was elected president. Other officers are: first vice-president, A. T. Hunter; second vice-president, A. H. Baum; third vice-president, G. A. Waters, treasurer, H. Shifrin; secretary, C. W. S. Sammelman. This club has about 1,000 members, and claims to be the second oldest organization of its kind in the United States.

NATIONAL ASSOCIATION OF BUILDINGS OWNERS AND MANAGERS will hold its 23d annual convention June 9-13 at Biloxi, Miss. The secretary is Louis B. Ermeling, Chicago.

PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION will hold its annual conference at State College, Pa., on June 24-25. This conference will be followed by the 1930 conference of the Pennsylvania Sewage Works Association on June 26 and 27. R. O'Donnell is secretary of the Sewage Works Association.

SMOKE PREVENTION ASSOCIATION will hold its annual meeting June 23-26 at Newark, N. J. Frank A. Chambers, Chicago, is secretary.

Obituary

WILLIAM F. CALLAHAN, of Omaha, Neb., vice-president of the Callahan-Walker Construction Co., died in Hollywood, Calif., on April 29. Mr. Callahan, who was 73 years old, had spent the greater part of his life in railroad construction work, having been a pioneer railroad contractor on the Union Pacific, Milwaukee, Rock Island and Burlington lines.

EUGENE PROSPER BENDER, a civil engineer, for a long time in the employ of the federal government and of the Canadian National Railway, died in Quebec, Canada, on May 6. Mr. Bender took part in the construction of the elevated railroad in New York City and had also done considerable work in India. He was among the first to advocate the construction of the Labrador railroad.

Construction Equipment and Materials

Strength of Copper-Steel Wire Increased

Coincident with the announcement that electric furnace steel is now being used exclusively in the manufacture of its steel core copper wire, the Copperweld Steel Co., Glassport, Pa. has issued a new table of revised standards for such wire, showing an increase in strength of approximately 50 per cent over values formerly used. Two grades of Copperweld wires and strands, known as high strength and extra high strength, replace the two grades formerly produced, which were known as standard tensile and extra high tensile. Aside from the increase in strength, characteristics of the wire remain unchanged.

Mark Will Identify Standard Core Drill Fittings

Commercial standards for diamond core drill fittings, adopted as the result of co-operation among manufacturers, drilling contractors and others interested in the subject, have been published in an illustrated pamphlet by the U. S. Bureau of Standards. The aim of the new standards is to make diamond core drill fittings produced by the various manufacturers, such as bits, casing and rods, interchangeable in the field, in so far as controlling diameters, threads and dimensions of joints are concerned, and also to provide a convenient series of nesting casings permitting three reductions in diameter below a 3-in. hole.

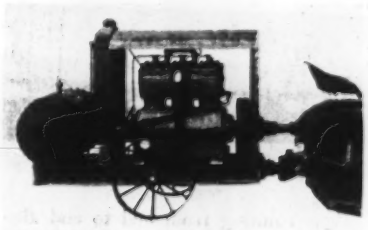
To insure that the fittings are actually interchangeable, the various plants have adopted working gages as a guide to satisfactory production. These can be procured only through the Diamond Core Drill Manufacturers Association, which has adopted an emblem to be attached to products made in conformity with the new standards or on packages containing standard goods. These emblems are supplied only to manufacturers who have purchased the necessary gages for producing the new standard diamond core drill fittings.

The pamphlet, entitled "Diamond Core Drill Fittings—Commercial Standard C. S. 17-30," may be procured from the U. S. Bureau of Standards at Washington, D. C., or from C. H. Rohrbach, secretary Diamond Core Drill Manufacturers Association, 90 West St., New York.

New Developments

Tractor Power Take-Off Drives Trailer Compressor

Mounted on a two-wheel trailer for extreme portability, a new air compressor produced by Schramm, Inc., West Chester, Pa., is driven from the power take-off shaft of the tractor

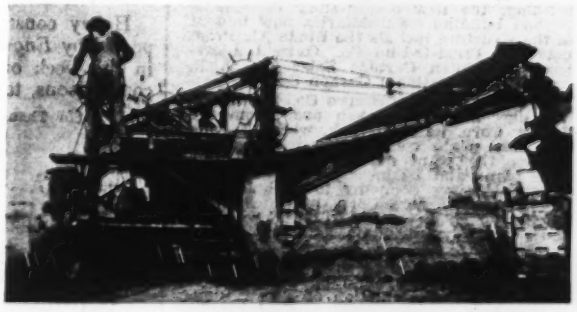


COMPRESSOR DRIVEN BY TRACTOR

which draws it by means of a double universal joint and a long spline shaft coupling. The compressor is shipped ready for attachment to the model 20 Cletrac tractor, and can be connected by unskilled labor. As it is easily detachable at any time, the tractor can be used for other purposes when desired. When detached, the power take-off can be used to drive other types of equipment.

Elevating Grader Designed for Low Power Consumption

In the new model 10 heavy-duty elevating grader recently announced by the J. D. Adams Co., Indianapolis, Ind., a number of new design features are included tending to secure light running qualities and ease in maintenance. Anti-friction bearings are used at every point of power consumption, the carrier belt is driven by a shaft and gear drive instead of by the usual chain, carrier and frames are designed to provide rigidity with light weight, and the complication of rear-wheel drive is avoided by the use of either a power take-off from the tractor or a separate motor. Other features include an automatic pan cleaner, a new belt tightener, an all-welded frame and Zerk lubrication.



REAR VIEW OF SHAFT-DRIVEN ELEVATING GRADER

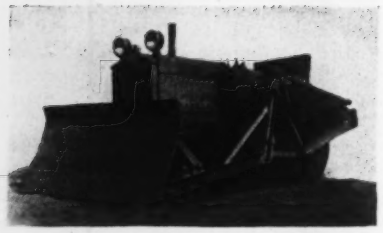
An outstanding feature of the new grader is the carrier, which is driven by a shaft and inclosed gears. The carrier drive shaft, mounted on ball bearings, runs back from the motor or power take-off connection, angles through a set of bevel gears, and drives another set of bevel gears at the drum by means of a square steel shaft telescoping in a heavy square steel tube. All bearings and gears are inclosed to protect them from dirt and dust. Both the upper drum and the lower roller of the carrier are mounted on ball bearings, and all carrier rollers are mounted on Timken bearings.

As the result of extensive use of anti-friction bearings, the manufacturers claim an extremely light running machine which requires the minimum of power for operation. It is also stated that the carrier is very easy on belts because of its rigidity and the effect of the ball bearings in keeping the belt true. Special attention is paid to belt protection by the use of steel plates, grids, guard rollers and other safeguards.

When operated from the power take-off, the use of a tractor of not less than 60 hp. is recommended for best results. This type of grader weighs 12,200 lb. When drawn by a smaller tractor, power for operating the carrier mechanism is supplied by a four-cylinder 39-hp. Hercules motor mounted on the forward part of the machine, increasing the weight to 12,700 lb. In either case the grader uses a 42-in. belt and is regularly equipped with a 28-in. disk plow.

Height of Bulldozer Blade Controlled by Gears

Gears inclosed in an oiltight housing attached to the tractor transmission case control the blade height on the Bully gear-operated bulldozer, produced by Niess & Co., Inc., Minneapolis, Minn., for attachment to Cletrac model 20, 30, 40 and 80-60 tractors. The power-transmission unit is composed of a pinion and bevel gear, together with a spur pinion and gear segment, used in connection with the Cletrac twin disk clutch and brake. Advantages claimed for the gear operation include greater speed and more positive action on the blade, wide travel radius and high lift. Control of the blade, which can be locked to the ground or allowed to float, is by means of a single lever. When the limit of lift is reached, the clutch automatically becomes disengaged. As the drawbar of the tractor is clear of the bulldozer, it can be used to pull other types of equipment, or, if preferred, the bulldozer itself can be re-

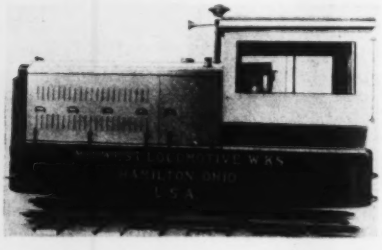


GEAR-OPERATED BULLDOZER ATTACHMENT

moved in about an hour, the transmission unit remaining in place. The unit is available either as a bulldozer, with a rigid blade, or as a backfiller, with adjustable blade. Anti-friction bearings are used in the transmission unit, all moving parts are on lubricated bearings, and electric welding is employed throughout.

New Gasoline Locomotives Use Anti-Friction Bearings

Eleven individual ratings are included in a line of gasoline engine driven haulage locomotives now being produced by the Midwest Locomotive Works, Hamilton, Ohio, in various gages for all types of industrial service. The main features of design and construction, which are uniform for the whole line, include the use of Timken bearings in journals and transmission, one-piece frame construction with low center of gravity, and the elimination of the subframe and of all bolts or rivets. Sizes available, when completed, include locomotives of 4, 5, 6, 7, 8, 9, 10, 12, 16, 20 and 25 tons. Models up to and including 12 tons are equipped with Hercules engines, while the 16-, 20- and 25-ton locomotives are powered by Climax engines. The drive is through a transmission giving four speeds forward and four in reverse through clutches and ring gears which drive the

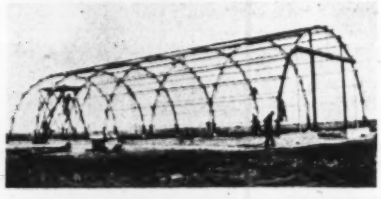


16-TON GASOLINE LOCOMOTIVE

sprockets. The drive sprockets are connected by chains to other sprockets keyed to the rear axles. The front axles are driven by chains from the rear axles on sizes ranging from 4- to 16-ton, inclusive. Side rods are used on the 20- and 25-ton models. A multiple disk, cork insert type clutch is used which is inclosed and runs in oil. Driving and transmission equipment are so mounted as to give the locomotive a high adhesive factor, about 25 per cent of the total weight as concentrated on the wheels. Service brakes are manually or air operated, and all control apparatus is grouped in the cab and so located that the operator has a clear view both front and rear. Sand boxes are carried under the hood in separate compartments directly over the exhaust pipe, which heats them and keeps them dry.

Field Construction Simplified in All-Steel Building

A new type of steel building, built without interior supporting posts, has been developed by the Columbian Steel Tank Co., Kansas City, Mo., to meet a demand for large storage space with a minimum of steel used. The building is made up of a series of steel trusses of welded construction, with angle iron



FRAME OF ALL-STEEL BUILDING

purlins running from end to end about 4 ft. apart, the whole covered by galvanized steel sheets. It is fabricated at the Columbian plant and may be set up by unskilled labor. The building pictured here is 40x90 ft. and is used to store combines and other large pieces of machinery on a Kansas wheat farm.

Business Notes

NATIONAL LUMBER MANUFACTURERS ASSOCIATION, Washington, D. C., received first honorable mention in the American Trade Association Executives' award for constructive activities by trade associations of benefit to the public, the individual industry and industry as a whole. First prize was awarded to the National Automobile Chamber of Commerce.

HERCULES MOTORS CORP., Canton, Ohio, has appointed Lon R. Smith assistant director of sales. Mr. Smith's duties will include supervision of export sales and sales promotion among Hercules distributors.

INLAND STEEL CO., Chicago, Ill., has completed a modern six-story brick office building at Indiana Harbor, Ind.

BROWN INSTRUMENT CO., Philadelphia, Pa., has consolidated its Chicago sales office and Mid-Western factory branch at 155 East Superior St., Chicago.

HEADLEY EMULSIFIED PRODUCTS CO., Philadelphia, Pa., has opened a Chicago office at 1 La Salle St.

UNION CARBIDE & CARBON CORP., New York City, has consolidated the Kansas City (Mo.) offices of its various units in one building, the new eleven-story Carbide & Carbon building. Subsidiaries now housed in the structure include the Linde Air Products Co., Prest-O-Lite Co., Oxweld Acetylene Co., Union Carbide Sales Co., J. B. Colt Co. and National Carbon Co.

PHOENIX MANUFACTURING CO., Joliet, Ill., has purchased and taken over from the Graver Corp. its steel tank, water-treating and steel plate construction business, including the plant at East Chicago, Ind. This plant and business will be operated by a subsidiary company to be known as Graver Tank & Mfg. Corp., of which P. S., W. F. and H. S. Graver will be vice-presidents and Edward N. Gosselin president.

PHILLIP CAREY MANUFACTURING CO., Lockland, Ohio, has recently become associated with the Aluminum Company of America in the production of a new high-temperature heat-insulating material to be manufactured under the trade name of Carey Aluminite. For this purpose the Carey company is planning the erection of a $500,000 manufacturing plant at East St. Louis, Ill., immediately adjacent to the present plant of the Aluminum company, from which it will receive processed material for the manufacture of insulating blocks, bricks and powder.

JOHNS-MANVILLE CORP., New York City, has purchased the assets and patents of the Stevens Sound Proofing Co., Chicago, manufacturer of products for sound insulation and for the deadening of vibration under machinery.

AMERICAN MANGANESE STEEL CO., Chicago Heights, Ill., announces that the Southern Manganese Steel Co., until recently operated as a subsidiary, has now become a part of the company as the Southern manganese steel division of the American Manganese Steel Co. Sales in the Pittsburgh district for both organizations will be handled by W. G. Hoffman. In New England, the company announces the appointment of John H. Coghlan, Cambridge, Mass., as direct representative.

New Publications

Steel Crossties—Four sections of steel crossties ranging in weight from 9.4 to 24 lb. per foot, manufactured by the CARNEGIE STEEL CO., Pittsburgh, Pa., are described in a 38-p. illustrated bulletin "Railway Steel Crossties," which also treats of track accessories and give suggestions for concrete track construction.

Welding—GENERAL ELECTRIC CO., Schenectady, N. Y., has reprinted a paper "Welding Steel Structures" presented by Andrew Vogel before the Brooklyn Engineers Club.

Grading—The Ball wagon grader, which combines the operations of digging, loading, transporting, dumping and spreading in one piece of equipment, is described in detail in a 16-p. bulletin 1210 compiled by the BLAW-KNOX CO., Pittsburgh, Pa.

Buckets—Class "K" digging clamshell buckets and electric motor buckets are described in two recent bulletins of the HAYWARD CO., New York City. The electric motor bucket is a hook-on type opened and closed by an electric motor mounted within the bucket.

Lightning Arresters—Investigations made by engineers in regard to the nature and magnitude of transient voltages caused by lightning in electrical systems are related in a 20-p. illustrated circular 1737-E published by the WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa. The investigations were made in developing the autovalve arrester, described in the publication.

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
May 1,	1930	205.86	April,	1930	351
Apr. 1,	1930	207.12	March,	1930	408
May 1,	1929	205.15	April,	1929	332
Average,	1929	207.02	Average,	1929	317
Average,	1928	206.78	Average,	1928	287
1913	.....	100.00	1913	.....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of May 15, with some comparisons, total as follows:

(In Thousands of Dollars)

	May 15, 1930	Average Preceding Four Weeks 1930	1929
Buildings:			
Industrial	$27,485	$6,014	$14,288
Other	48,165	42,125	32,344
Streets and roads.	23,249	15,782	18,236
Other eng. constr.	36,599	12,861	13,605
Total	$135,498	$76,783	$78,474

Total, all classes, Jan. 1 to May 15:

1930	$1,429,760
1929	1,748,088

Unit Prices From Current Construction Bids

N. Y. Airport Bids on Nine Structural Items

BIDS were asked Jan. 7, 1930, by the New York Department of Docks on a municipal airport (Floyd Bennett Field) in Brooklyn, comprising eight steel frame and masonry hangars with lean-to, each 150x140 ft. in plan. Twenty-two bids were received, ranging from $1,083,000 to $1,643,280. The spread between low and average is 26 per cent. Prices of the lowest three bidders and the weightings of the nine items of the job were as follows:

I.	Hangar foundations, including excavation, grading, concrete piles, wall foundations, but not concrete floors	$156,000 (14.4%)	$137,500	$101,837
II.	Subsoil structures	110,000 (10.2%)	145,400	83,591
III.	Structural steel framing on buildings	148,00 (13.7%)	162,000	192,000
IV.	Covering for steel framing on buildings	186,000 (17.2%)	172,000	210,361
	A—Carpentry, including wood roof deck, doors, windows, hardware			
	B—Masonry, including brickwork, cut-stone trim			
	C—Sheet-metal work			
	D—Roofing, including special cork or equal insulation on hangar roofs, tar or asphalt and gravel on hangar and lean-to roofs, copper gutters			
V.	Asphalt block paving	120,000 (11.1%)	141,000	149,597
VI.	Sliding aluminum alloy doors in each of eight hangars, complete	105.000 (9.7%)	154,000	155,645
VII.	Concrete hangar floors	37,000 (3.4%)	25,000	31,460
VIII.	Concrete apron	200,000 (18.4%)	160,000	196,575
IX.	Painting, glazing	21,000 (9%)	20,000	20,042

Principal Quantities

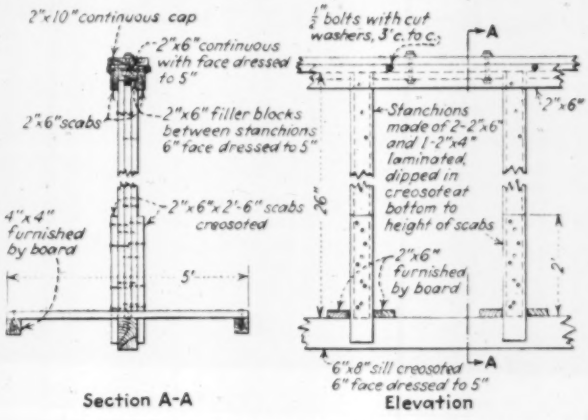
Concrete piles under sliding doors, 15 ft. each	80
Timber piles under piping, 12 ft. each	250
Concrete foundation piles, 35 ft. each	920
Concrete, mass, cu.yd.	2,900
Structural steel, tons	1,600
Common brick, M.	680
Roofs, hangar, sq.ft.	132,400
Roofs, lean-to, sq.ft.	33,600
Paving, asphalt block, sq.yd.	44,100
Sliding hangar doors	192
Steel sash, sq.ft.	34,900
Concrete for hangar floors, 6 in. thick, sq.yd.	14,000
Concrete for apron, 7 in. thick, sq.yd.	69,600
Earthfill, to be furnished, cu.yd.	11,500

Timber Supports for Cotton Bales, New Orleans

BIDS were opened Feb. 28 for constructing three lines of timber-framed supports in 87 existing compartments and laying in each compartment two plank runways at the Public Cotton Warehouse, New Orleans. Bids were submitted by fifteen contractors on three items: (1) in 30 compartments, equipped for flat bales; (2) in 57 compartments for standard bales; (3) hauling shell fill away from compartments.

The board of commissioners will move the cotton from the compartments, will remove the racks from the floor, separate sills and crosspieces forming them, and turn over to the contractor all material suitable for sill construction where used materials are permitted. The contractor may use up to six of the warehouse cranes for $8 per day each with operator. Power for electric tools is free, as is space for storing materials.

All new timber is Southern yellow pine. The 26-ft. pieces for stanchions are dressed to 1⅝x3⅝ in. The center sills under the cotton bales on shell fill are 6-in. width dressed to 5-in. and with 8-in. depth of full size. Other sills on shell fill are rough. Sills on paved areas, the center sills under plant runways, and the scabs at the bottoms of the stanchions are treated by full-cell process with 12-lb. creosote oil. The contractor provides a tank for dipping bottom ends of stanchions 2 ft. in hot creosote oil.


2"x10" continuous cap
2"x6" continuous with face dressed to 5"
2"x6" scabs
2"x6" filler blocks between stanchions 6" face dressed to 5"
4"x4" furnished by board
2"x6"x2'-6" scabs creosoted
5'
Section A-A
⅞" bolts with cut washers, 3'-c. to c.
A
Stanchions made of 2-2"x6" and 1-2"x4" laminated, dipped in creosote at bottom to height of scabs
2"x6"
2"x6" furnished by board
6"x8" sill creosoted 6" face dressed to 5"
Elevation

DETAILS OF STANCHIONS, NEW ORLEANS PUBLIC COTTON WAREHOUSE

Contract calls for supports in 87 compartments, 30 for flat bales and 57 for standard bales. Each compartment, 32x101½ ft., has three longitudinal rows of stanchions, 22 per row for flat bales and 30 per row for standard bales, capped as shown here. Stanchion rows are on 10½-ft. centers. Each compartment has two 5-ft. longitudinal runways at ground level, made up of 2x12-in. planking on 4x8-in. creosoted sills on 14-ft. centers.

The first and second items distinguish between two slightly different arrangements of supports required to store flat and standard bales. The third item provides for removal of excess shells over those needed for grading the shell fill. Below is a working schedule for the contractor and to which the compartments will be emptied at half-month intervals. The contractor is allowed 45 days for completion after each group is turned over to him.

	Compartments		Compartments
Group I—April 16	13	Group V—June 16	13
Group II—May 1	13	Group VI—July 1	14
Group III—May 16	12	Group VII—July 16	11
Group IV—June 2	11		

The tabulation lists the lowest two bidders: (A) O'Brien Construction Co., Q & C Bldg.; (B) O. M. Gwin Construction Co.

	A	B
In 30 compartments for flat bales	$790.00	$805.00
In 57 compartments for standard bales	889.00	969.00
Hauling shell fill away 500 cu.yd.	0.50	0.75
	$74,623	$79,758

Concrete Paving in Maryland

SEVEN contracts let by the Maryland State Roads Commission in April totaled 209,410 sq.yd. of plain concrete. The lowest two unit bids on each and their weighted averages were as follows:

One Course Plain				
Sides	Center	Cu.Yd.	Low	Second
9-in.	6 3-in.	29,050	$1.68	$1.70
9-in.	6 3-in.	23,500	1.69	1.77
9-in.	6-in.	5,250	2.18	2.20
9-in.	6-in.	4,200	2.00	2.09
9-in.	....	36,300	1.55	1.57
9-in.	....	19,800	1.60	1.62
....	7-in.	32,800	1.36	1.36
8-in.	....	29,250	2.15	
8-in.	....	29,250	1.68	1.74
Total quantity		209,410		
Weighted average			$1.68	$1.71

The unit prices on p. 710 of the April 24 issue, headed Sanitary Sewers at Dallas, refer to a contract in *Austin*, Tex.

Unit Prices From Current Construction Bids

Enlarging Morena Dam and Spillway for San Diego

THE Morena rockfill dam, completed in 1912 as a part of the San Diego (Calif.) water-supply system, is to be enlarged for the second time, as shown in Fig. 1. The dam rises 164 ft. above the bed of Cottonwood Creek and has a concrete toe wall on the upstream side extending 112 ft. below streambed, is 505 ft. long on top, 300 ft. thick at base and 20 ft. at top. As originally built it contained 306,000 cu.yd. of material and cost $1,110,000, including a concrete tower 155.5 ft. high. The new work (bids March 17, 1930) requires 18,000 cu.yd. excavation, 1,000 cu.yd. concrete and rubble masonry, 38 tons reinforcing and structural steel, furnishing and installing 22 automatic flash gates (Fig. 2) and raising the outlet tower. The contract price is $61,489.

The site is 9 miles northwest from Barrett railway siding, 67 miles east from San Diego (35 miles by air line), and 2 miles east from Campo, on the San Diego & Arizona Railway. Only citizens of San Diego may be employed, and work must be completed Oct. 1, 1930, with a penalty of $100 per day. The city may impound water to the fullest extent practicable as the work advances.

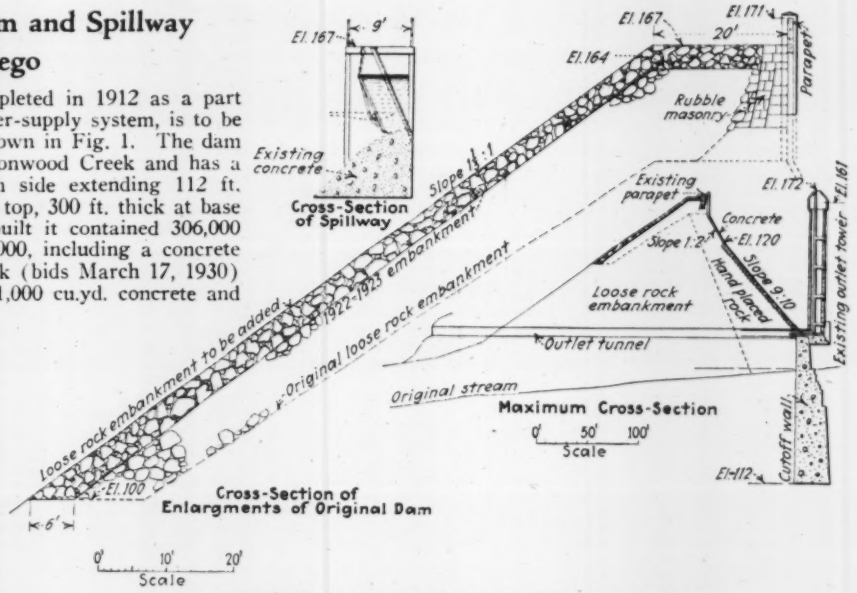


FIG. 1—SECTIONS OF MORENA DAM ENLARGEMENT

Excavation—Class 1 excavation is all material except solid ledge rock and old concrete or rubble masonry. Class 2 is ledge rock and masonry. Suitable material may be used in the concrete and rubble work. Other material is placed in the embankment of the dam, and the cost of this work is included in the unit prices for excavation.

Materials—Concrete for raising the upstream face of the dam 3 ft., for raising the outlet tower 11½ ft., and in the spillway piers and bridge slab, is 1 part by volume cement, 2 parts sand and 4 parts brown rock or gravel. Reinforcing steel is furnished by the city at Sutherland dam site and hauled to the job by the contractor. If natural deposits yield sand that will produce a 1:3 mortar of strength equal to the same with standard Ottawa sand, such sand may be used. Otherwise the contractor manufactures sand by crushing and screening. Coarse aggregate is obtained from the excavated material where possible. Cost of preparing either rock or gravel is included in the masonry prices.

Rubble masonry is uncoursed rubble laid in 1:2 mortar. Stones are at least 6 in. thick by 12 in. long and are bedded on the largest face.

Item 14, for drilling 2-in. holes in masonry, includes grouting reinforcing bars in place.

Flash Gates—One-sixth of the contract price is for 22 flash gates 9x12½ ft. (Fig. 2), complete with trunnions, rubble water stops, angle bracket stops, chains and chain inserts. The contractor furnishes pieces of steel to be tested by the city. Metal parts are given a shop coat of red lead and oil and a field coat of graphite, lead and oil or white lead and oil, or "Biturine" or equal, depending on whether exposed to air or water. Castings are coated with Biturine or coal-tar pitch varnish.

Bidding—The table gives the unit prices of the four contractors: (A) Gist & Bell, Arcadia, $61,489 (award); (B) Monarch & Breen, Inc., $66,515; (C) Miracle Construction Co., $71,203; (D) Butterfield Construction Co., $76,228. H. N. Savage is engineer in charge for the San Diego Bureau of Water Development.

	A	B	C	D
8,000 cu.yd. excav.—dam embank.—Class 1	$1.15	$0.90	$1.30	$1.90
1,000 cu.yd. excav.—dam embank.—Class 2	1.30	1.50	1.80	2.25
800 cu.yd. excav. for rubble masonry—Class 1	1.00	1.25	1.30	2.00
1,000 cu.yd. spillway excav. opposite crest—Class 1	1.30	1.25	1.40	1.60
1,400 cu.yd. spillway excav. opposite crest—Class 2	1.50	2.00	1.90	2.40
2,000 cu.yd. spillway excav. below crest—Class 1	2.50	2.40	2.50	2.75
4,000 cu.yd. spillway excav. below crest—Class 2	2.50	2.40	2.50	3.15
400 cu.yd. concrete exclusive cement—steel	14.00	25.00	29.00	22.50
600 cu.yd. rubble masonry—excl. cement	8.50	9.00	7.45	7.50
800 bbl. cement in place	3.50	4.50	3.40	2.80
55,000 lb. reinf. steel—hauling and placing	0.03	0.05	0.035	0.025
20,000 lb. structural steel except flash gates	0.05	0.10	0.08¼	0.07
60 each 1-in. steel wall anchors	2.00	2.50	3.15	2.50
1,500 ft. 2-in. holes in concrete masonry	1.50	0.40	0.32	0.75
300 ft. 1-in. holes in concrete masonry	1.00	0.30	0.25	0.60
100 ft. expansion joints	0.50	0.20	0.37½	0.25
800 ft. 2-in. pipe railing	1.50	2.00	2.32	1.75
22 automatic flash gates	480.00	500.00	575.00	525.00
44 stop plank groove cover plates	12.00	12.00	14.00	13.00
1 outlet tower cupola ladder	50.00	50.00	41.50	40.00
1 22-in. manhole frame and cover	50.00	50.00	38.00	35.00
1 20x28 in. manhole frame and cover	50.00	80.00	76.25	75.00
1 6-ft. dia.—dome cover plate	100.00	60.00	62.75	70.00
60 lb. ¾-in. steel ladder rungs	0.10	0.20	0.26	0.10
5 valve-stem stuffing glands	75.00	75.00	80.00	75.00

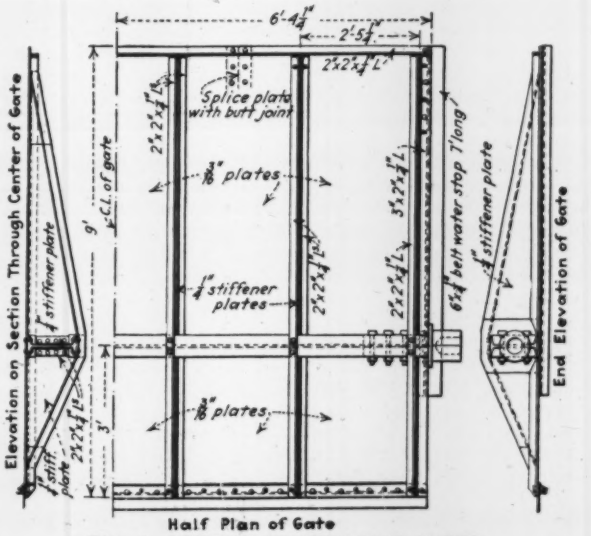


FIG. 2—DETAILS OF SPILLWAY GATES